Instruments *and* **AUTOMATION**

Here's The New Liquid Level Control Pilot Everybody's Talking About!

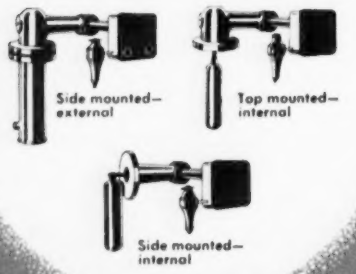
It's The New BS&B CLIMAX Type 1450!

After more than two years of development and thorough field testing under all conditions, the new BS&B CLIMAX Type 1450 Liquid Level Control Pilot is now available, and is already the most talked about instrument of its kind in the industry today!

Type 1450 is the *only* liquid level controller on the market which is so versatile that it can be used for liquid level transmission service, proportional throttling service *and* for "on-off" snap action! This makes it easy for you to transfer it quickly from one service to another, as your needs may require.

You will be surprised and pleased with its performance and simplicity. Call or write your BS&B Representative. He will be glad to give you the complete story on this all-new liquid level control pilot.

Type 1450 Mounts To Torsion Tube Controller In 3 Ways:



CONSTRUCTION FEATURES

- V Weatherproof Case Of Die Cast Aluminum Designed For Universal Mounting.
- V Compact Size — 8" x 8" x 4".
- V Two-Way Door Opens From Either Left Or Right, As Convenient.
- V Straight Line Piping.
- V Push Button Feed Orifice Cleaner.
- V Pilot Action Reversible By Moving A Single Link, Without Tools.
- V Snap Action Or Proportional Band Settings Can Be Made Without Tools.
- V No Loose Linkages, Resulting In Easier Adjustment And Greater Sensitivity.
- V Easy Parts Replacement Or Assembly.

OPERATIONAL FEATURES

Straight Line Proportional Action!

- V Factory Calibration Of Proportional Bellows, Feed Orifice Nozzle and Proportional Snap Action Band Scale.
- V Spring Loaded Bellows With Built-In Overtravel Protection.
- V Flow Tested Feed Orifice Nozzle With Graduated Micrometer Set Point Adjustment.
- V Reflects Changes In Liquid Level, Changes In Gravity.
- V Can Be Used For Liquid Level Transmission Service, Proportional Throttling Service Or "On-Off" Snap Action.

Improved Sensitivity and Faster Controller Response Through The Power Relay Mechanism

- V Double Diaphragm, Pressure Balanced.
- V Molded Diaphragms.
- V High Capacity Pilot Valve.
- V Intermittent Bleed.

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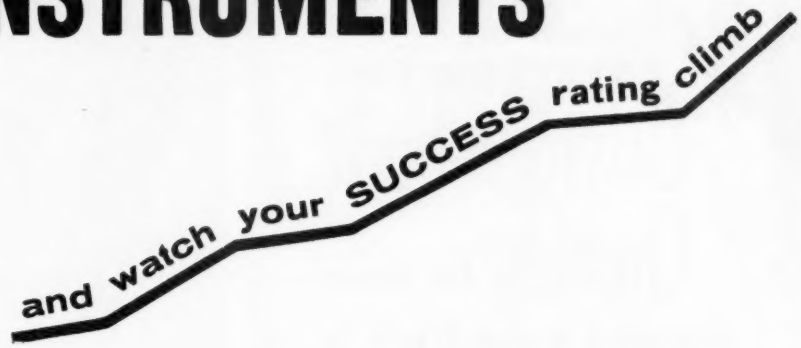
For more information circle 1 on inquiry card.

LEARN INSTRUMENTS



Modern instrumentation offers you a new world of opportunity. "Automation" is the big news today. More and more factories and refineries are substituting instruments and automatic controls for skilled operators and machinists.

Many chemical and manufacturing processes are already completely automatic. One of the big atomic plants, for example, has 100,000 instrument dials, 760 miles of instrument and control piping. Oil refineries, electric power plants, chemical factories are now operated by highly skilled crews **using instruments.**

Growing demand for trained instrument men

The call is out for highly trained instrument specialists. Designers. Operators. Salesmen. Installers. Maintenance experts. These are the men who need fear no recession. They write their own tickets. **And you can join them!**

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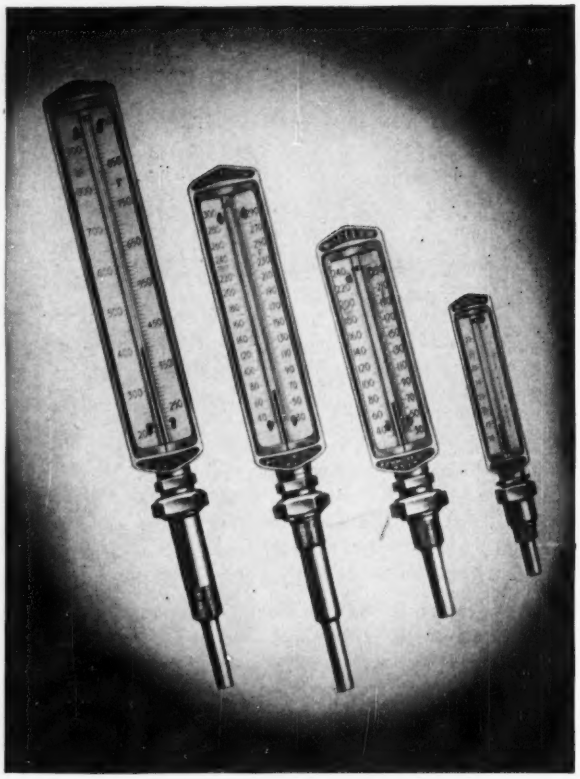

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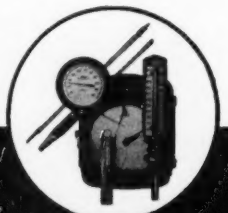

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Cover Story

Instrument panel section using Dekoron "P" tubing, "Poly-Flo" fittings and racks to tube Foxboro instruments. Racks snap into "Unistrut" framing to secure tubes. Instrof trough supports "Impervapak Poly-cor" from process to panel. Sound-powered telephones are used for checking. For story see page 1614. (Photo courtesy Carbide and Carbon Chemicals Company.)

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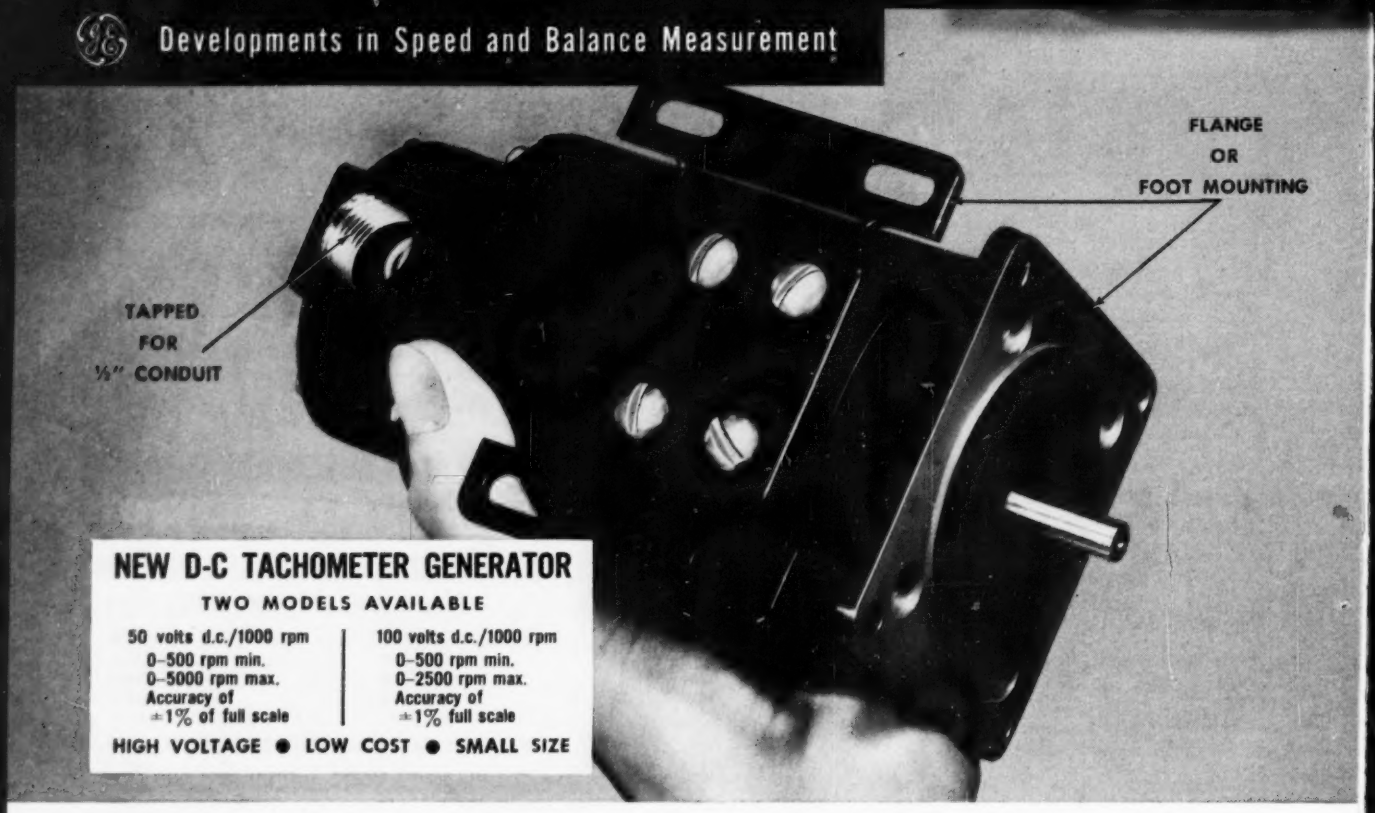
Developments in Speed and Balance Measurement



NEW D-C TACHOMETER GENERATOR

TWO MODELS AVAILABLE

50 volts d.c./1000 rpm	100 volts d.c./1000 rpm
0–500 rpm min.	0–500 rpm min.
0–5000 rpm max.	0–2500 rpm max.
Accuracy of ±1% of full scale	Accuracy of ±1% full scale

HIGH VOLTAGE ● LOW COST ● SMALL SIZE

ANNOUNCING the NEWEST in General Electric's

The new General Electric d-c tachometer generator provides a low-cost answer to many speed-measurement and control problems.

Designed to occupy a minimum of space, the new generator can be either flange- or foot-mounted—and it can be installed horizontally or vertically. This high versatility allows the equipment to be direct coupled, geared, or belt driven, as needed.

Available in two different models, the new generator can be supplied with an output voltage up to 100 volts per 1000 rpm. This feature makes it ideal for use as a pilot exciter on many control applications.

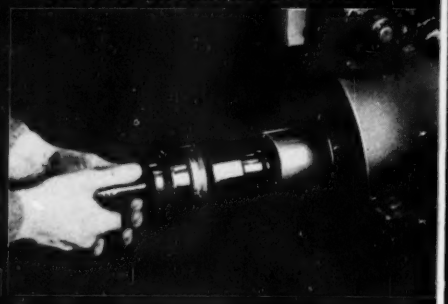
This new addition to the G-E complete line of speed-measuring devices, means that you are now

More News about . . . General Electric Instruments for Speed and Balance Measurement

HAND TACHOMETER

PORTABLE, AND LIGHTWEIGHT, this new instrument features 3-scale versatility—accurate 1-scale reading. Wide speed ranges are available up to 20,000 rpm.

DYNAMIC BALANCING EQUIPMENT



FOR PRECISION BALANCING, with speeds from 300 to 6000 rpm, of rotating parts weighing 15 pounds or more, this equipment is portable, easy to use.

For more information circle **5** on inquiry card.

Your speed-measuring problem can be answered from G.E.'s complete line of a-c or d-c tachometer generators . . . .

50 v., d.c./1000 rpm

0–200 rpm min.

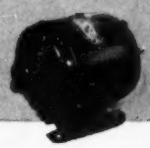
0–5000 rpm max.

Accuracy of ±1% full scale

200 v., d.c./1000 rpm
or
100 v., d.c./1000 rpm

0–200 rpm min.
0–1800 rpm max.
or
0–3600 rpm max.

Accuracy of ±1% of full scale



10 v., a.c./1000 rpm

0–500 rpm min.

0–5000 rpm max.

Accuracy of ±4% of full scale

43 v., a.c./100 rpm

0–25 rpm min.

0–500 rpm max.

Accuracy of ±4% of full scale

7 v., a.c./1000 rpm

0–2000 rpm min.

0–8000 rpm max.

Accuracy of ±4% of full scale

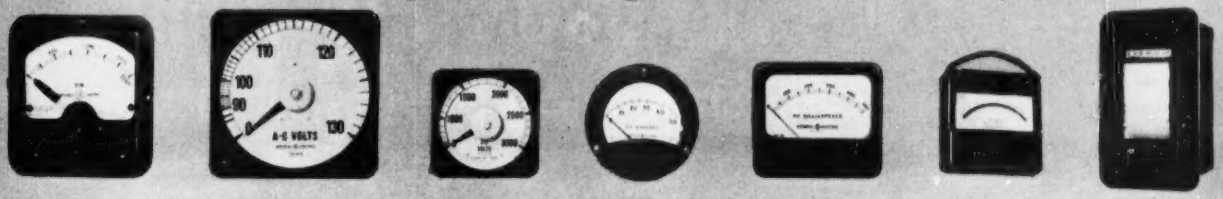
2.5 v., a.c./1000 rpm

0–6000 rpm min.

0–15000 rpm max.

Accuracy of ±4% of full scale

. . . . and quality indicating and recording instruments.



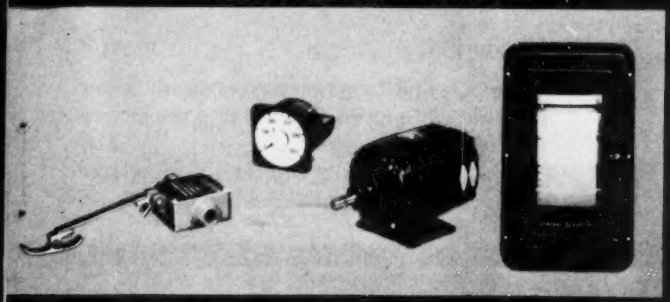
Complete Line of Speed-measuring Equipment

better able to choose a combination of tachometer generator and instrument that meets your specific requirement. Whatever your voltage, speed, accuracy, or cost consideration, General Electric has the system to do the job, and do it well.

Among the many G-E instruments that can be used with the tachometer generators are panel as well as portable indicators. These precision-indicating, or fast-acting recording instruments provide dependable speed checks or records.

For more information about General Electric speed-measuring systems, contact your nearest G-E Apparatus Sales Office, or clip coupon below for free bulletins giving details of the equipment.

PRODUCTION SUPERVISOR'S KIT



IDEAL FOR CONTINUOUS-PROCESS operations, the system includes tachometer generator, indicator, recorder, and web-break detector. Saves valuable time by providing up-to-the-minute data on machine performance right in the supervisor's office.

SECTION B605-72, GENERAL ELECTRIC COMPANY, SCHENECTADY 5, NEW YORK

Please send me the following bulletins:

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- ☐ Hand Tachometer (GEC-241)
- ☐ Dynamic Balancing Equipment (GEC-320)
- ☐ Production Supervisor's Kit (GEC-816)

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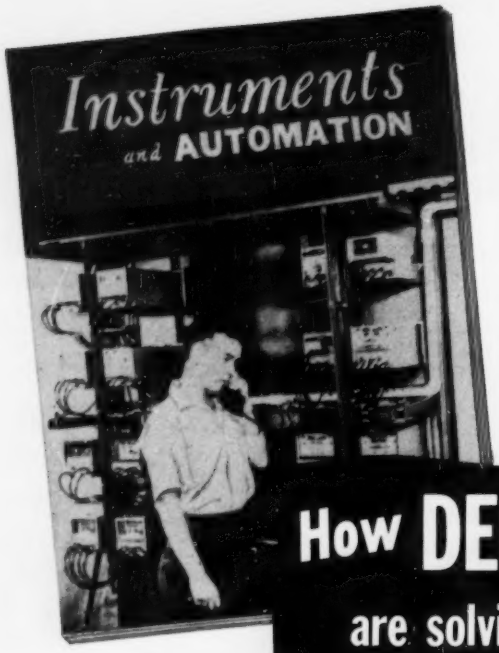
GENERAL ELECTRIC

For more information circle 5 on inquiry card.



Front Cover Story...

ANY MONTH!

How DEKORON INSTRUMENT are solving tubing problems and slashing

Dekoron is more than just a name for chemically resistant tubing. For the Dekoron trademark now covers a complete line of tubing, fittings, valves, and specialties for completely tubing up pneumatic instrument systems. Each unit in the line is specifically designed for instrument use—that's why they cost less to buy, less to install and last longer.

Is Dekoron QUALITY proven?

Yes! After 10 years in corrosive atmospheres, Dekoron plastic-coated metal tubing is still giving trouble-free service where 316 stainless steel failed in 6 months.

Yes! The best-known names in industry, both large and small, rely on Dekoron products.

Is Dekoron RESEARCH proven?

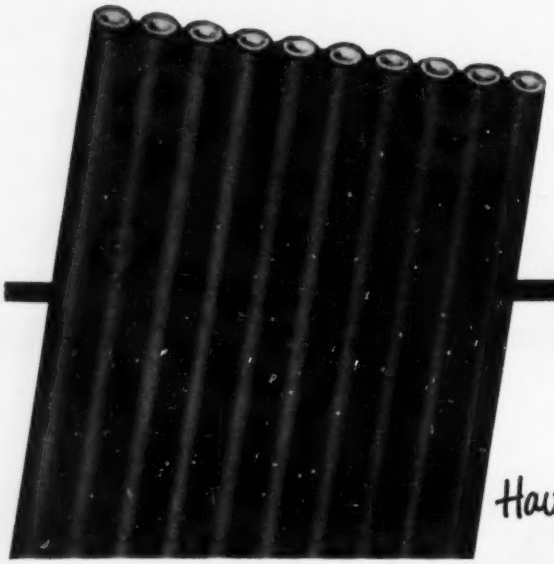
Yes! As pioneers in extruding plastics, we have developed such industry standards as Dekoron plastic-coated metal tubing, Metl-Cor, Poly-Cor, and "P" tubing. Dekoron Ribbon and Dekoron plastic fittings are the latest dividend from Dekoron research.

Yes! Constant research has reduced installation costs still further through development of such companion products as junction and union boxes, tube racks, and E-Z fittings.

Is Dekoron SERVICE proven?

Yes! Qualified representatives in all major chemical and processing areas plus the factory staff are at your service.

Yes! Immediate shipment is made from large stocks of standardized Dekoron products. AA-288

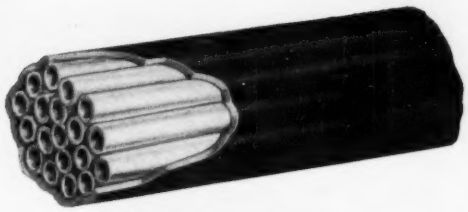


DEKORON RIBBON

A new product consisting of 10 "P" tubes, or copper or aluminum tubes sheathed in ribbon of vinyl plastic. Individual tubes can be peeled from Ribbon at any place or time.

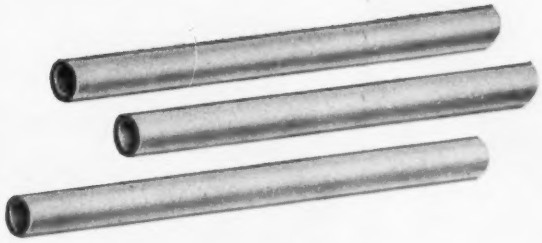
Have you seen the new Dekoron valves?

For more information circle **6** on inquiry card.



DEKORON POLY-COR®

Chemically resistant instrument line harness in long lengths. Composed of individual polyethylene tubes covered with vinyl sheath. The flexibility of this multiple tube harness means you install from 4 to 19 tubes in less than half the time of a single metal tube.

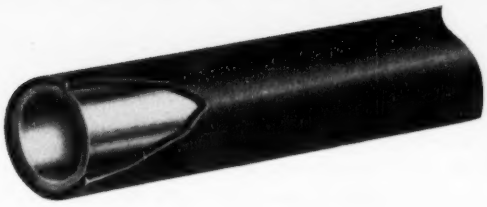


DEKORON "P" TUBING

Single-line polyethylene tubing. Installs in a fraction of the time of ordinary metal tubing. Use with Dekoron E-Z or Dekoron plastic fittings.

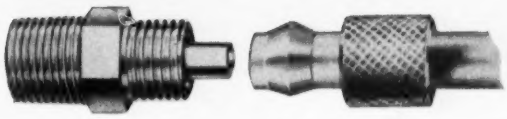
TUBING SPECIALISTS...

installation costs in plants all over the country



DEKORON PLASTIC-COATED METAL TUBING

Thick polyethylene or vinyl coating extruded over core tube of copper, aluminum or steel.

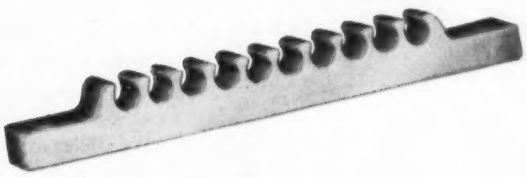


DEKORON E-Z FITTINGS

Quick, leakproof, shakeproof joints without special tools. For Dekoron "P" tubing and Dekoron Poly-Cor harness.

DEKORON PLASTIC FITTINGS

The first chemically resistant fittings designed expressly for use with plastic tubing. Assemble in a jiffy without tools or tubing preparation.



DEKORON TUBE RACKS

For a neater, more workmanlike installation. See Front Cover picture.

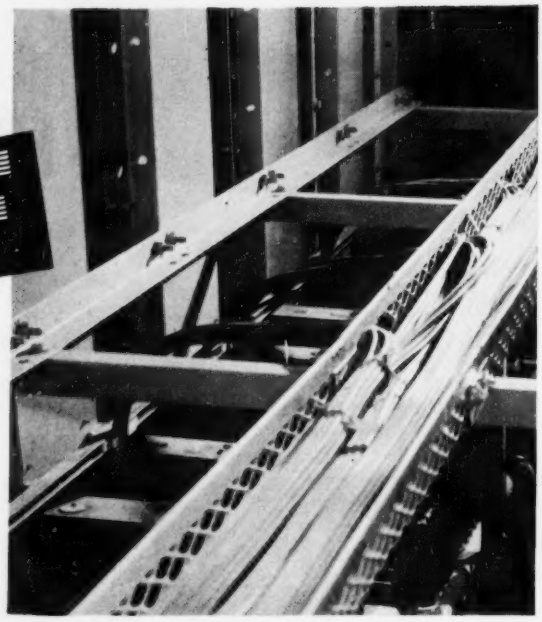
Dekoron® products

QUALITY • RESEARCH • SERVICE

SAMUEL MOORE & COMPANY • MANTUA, OHIO

DEKORON PRODUCTS DIVISION

Instrof trough installed at Carbide & Carbon Chemicals Corporation, South Charleston, West Virginia.



INSTROF®

the ideal method for supporting

PLASTIC INSTRUMENT TUBING

Instrof, because of its ease of assembly, and low installation cost, again proves the most practical method of supporting instrument tubing.

In addition to the many systems of aluminum, copper and armored tubing, the use of Instrof is also highly economical with the new plastic tubing which also boasts, among other virtues, quick installation time and low cost. Instrof and plastic tubing combine to bring to the Instrument Industry an inexpensive, versatile and dependable system for control tubing and support.

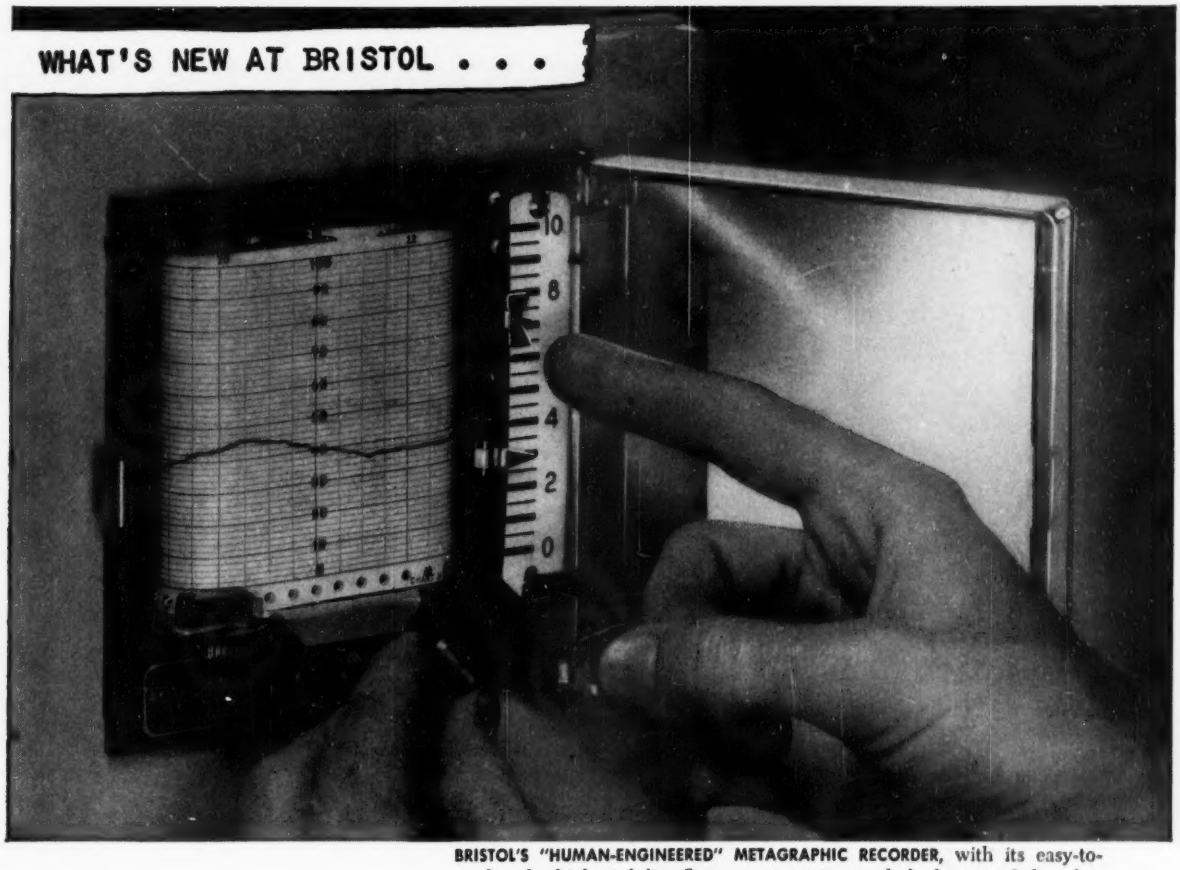
Instrof is a standardized system of expanded metal trough which affords uniform and continuous support for plastic as well as metal tubing. It is available in widths of 3″, 6″, 9″, 12″, 18″ and 24″, and in 1½″ and 3″ high sides. A wide range of fittings (tees, elbows, risers, etc.) and fastenings permit the system to be rapidly assembled at the job site to conform to almost any layout. Also, special fittings can be fabricated to specification for extraordinary conditions.

For further information on the Instrof system, write today for the new 12-page illustrated Bulletin 254, or consult with the Instrof Representative nearest you—there's no obligation, of course.

INSTROF INCORPORATED

4923 PENTRIDGE ST. PHILADELPHIA 43, PA.
PHONE—SARATOGA 9-0104

For more information circle **7** on inquiry card.



BRISTOL'S "HUMAN-ENGINEERED" METAGRAPHIC RECORDER, with its easy-to-read scale, high-visibility fluorescent pointers and shadow-proof door has earned the distinction of being the "biggest little instrument in the business."

Instrument men call Bristol's METAGRAPHIC Recorder

"... the biggest little instrument"

Sounds contradictory, but it's true. Take a look at one of our new METAGRAPHICS mounted on a panel board alongside of other instruments. The Bristol unit stands out – seems bigger than the rest – although chances are it's actually smaller (5" x 5½"). The answer is that the Bristol instruments have been "human-engineered", making them easy to read, and clearly visible at greater distances.

The air-operated METAGRAPHIC, which records pressure, temperature, vacuum, flow, differential pressure, and liquid level, offers these big advantages:

SIMPLICITY . . . fewer moving parts, fewer adjustments, and less service required. Range changes can be made in seconds. True plug-in service.

CONTINUOUS VALVE-POSITION INDICATION . . . on same instrument scale as set-point scale, gives continuous data on control valve position–makes "bumpless" transfer possible simply by matching pointer positions – no need to read actual scale values – minimizes reading errors – speeds operations.

CONTINUOUS OPERATION . . . complete unit can be retracted for inking pen, and for set-point and zero adjustment without disturbing record or control.

Get the whole story on the "human-engineered" METAGRAPHICS – how they can help you get more accurate measurements, faster and easier. Write us today. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.

6.4.4R

BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle 8 on inquiry card.

Added Evidence that—

Everyone Can Count on VEEDER-ROOT

REPORTER AT LARGE . . . that's what you might call this new Veeder-Root Reset Magnetic Counter . . . adaptable to remote counting from machines or processes to central boards or instrument-clusters, wherever you want to put them. NOW . . . what can your imagination do with these few facts? For the *full facts,* write:

VEEDER-ROOT INCORPORATED
"The Name That Counts"
HARTFORD 2, CONNECTICUT
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"Counts Everything on Earth"

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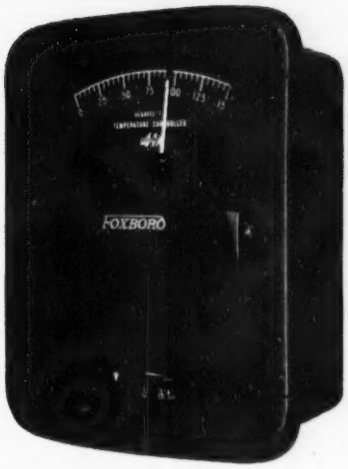
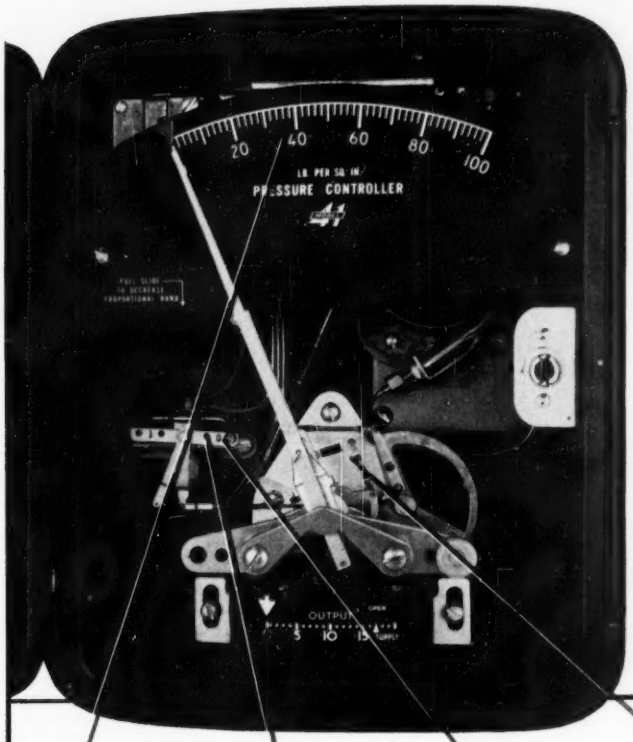
Now!
An even **BETTER** Controller for simple processes!



...the improved Foxboro M/41A Indicating Controller



Here's the Foxboro Controller that proved itself in thousands of successful applications throughout industry! Now, with brand new design features, it's better than ever.

The M/41A Controller offers a new, snappy on-off action, or smooth proportional control action easily adjustable from .25% to 25%. It employs the famous M/40 controller movement — free from backlash, lost motion, and friction. This is a rugged, low-cost, compact controller using standard M/40 parts *throughout* . . . easy to get at . . . easy to service.

For control of simple processes—temperature, pressure, liquid level, or humidity — it will pay you to investigate the convenience and the precise, reliable performance of the Foxboro M/41A Indicating Controller. Write for Bulletin 5A-13.

New Design Features

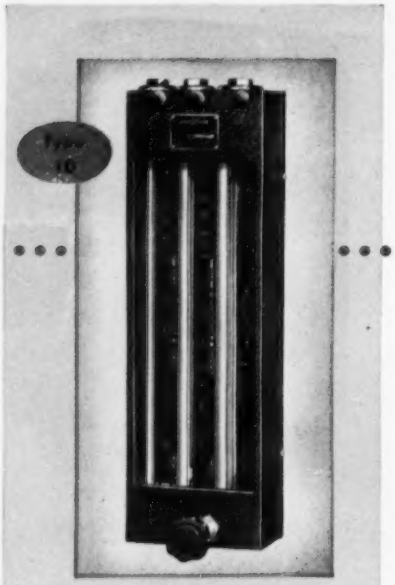
- Longer Scale — 5" effective length.
- Snappy "On-Off" Control Action on measurement change of only ⅛ of 1% scale.
- Alternate Proportional Action adjustable from ¼ of 1% to 25%.
- "Permaligned" Precision Controller Movement — Exclusive Self-Aligning Ball-Linkage—Non-Backlash Vernier Index Drive
- Simple Rugged Construction—All Parts Easily Accessible

THE FOXBORO COMPANY, 4610 NEPONSET AVE., FOXBORO, MASS., U.S.A.

FOXBORO REG. U.S. PAT. OFF. **INDICATING CONTROLLERS**

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

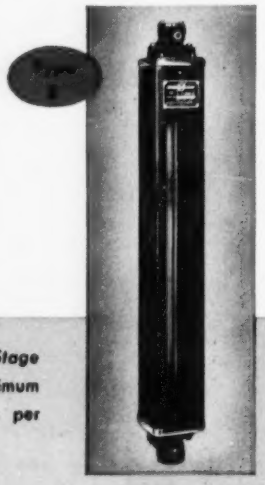
For more information circle **10** on inquiry card.

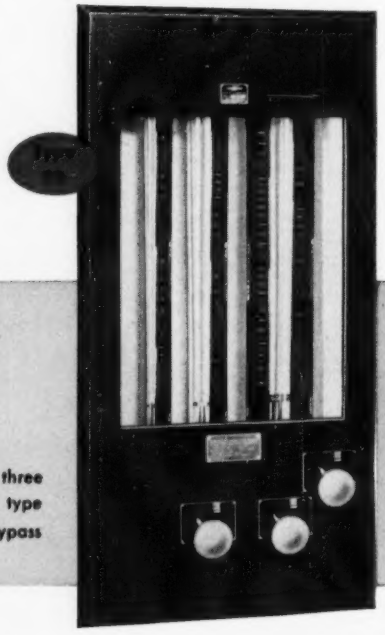


DO YOU USE FLOWMETERS FOR LABORATORY RESEARCH OR PRODUCTION?

COX FLOWMETERS

are designed for flow rate measurement of fuels (such as gasoline, kerosene, diesel and jet fuel) and of many liquids and gases. They are built for use in the laboratory, in a wide range of production processes, or for a combination of the two.





For the Laboratory: *Type 10 Multiple Stage Flowmeters,* designed as a compact laboratory instrument for precise measurement of smaller fluid flow rates.

For Production: *Type 8 Single Stage Flowmeters,* engineered for a maximum flow capacity of 50,000 pounds per hour.

For Both: *Type 12 Multiple Stage Flowmeters,* available in three series — the 40, the 90, and the 100. Each has logarithmic type scales for excellent readability and can be equipped with a bypass orifice to greatly increase flow capacity.

Individually graduated scales; patented "Inner Wall" guides that insure perfect float centering within the metering tube; and extra-sensitive floats are a few of the major features of Cox Flowmeters. Scales are graduated for a specific fluid. Scales for metering other fluids can be easily interchanged. Multiple Stage Flowmeters are available for wide flow ranges, and bypass orifices can be built in which greatly increase the flow capacities without increasing panel space required.

The Type 12, 40 Series Flowmeter, available in single and multiple-stage units, is firmly established as the most accurate variable-area flowmeter now made. Each individually graduated logarithmic scale is accurate to within ±½ percent of the actual flow at any point on the scale. It is readable to within ±¼ percent of indicated flow at any point.

Look for Other CRL *Products*

AIR FLOWMETERS
CARBURETOR FLOW STANDS
ENGINE INDICATORS
FLOWMETER CALIBRATING STANDS
FUEL NOZZLE TEST STANDS
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Makers of Since 1912

U. S. PATENTS 2,384,800 2,389,957 2,403,849, 2,417,352

For more information circle **11** on inquiry card.

AUTOMATIC CONTROL OF VARIABLE SPEEDS

See "AUTOMATION IN ACTION" At Booth Number 2012— National Metals Exposition, Chicago, Illinois, Nov. 1 thru 5, 1954

An operating model of automatically controlled processes by U. S. Varidrive with Varitrol control will be displayed.

MOTORS

¼ TO 50 HP

U.S. VARIDRIVE

THE MIRACLE MOTOR

WITH

VARITROL®

Now any process requiring automatic variable speeds can be driven by U. S. Varidrive with Varitrol control. For more than 20 years the Varidrive has been recognized as the most compact and efficient device for obtaining variable speeds, with ratios up to 10:1 and capacity from ¼-50 HP. Varitrol is a new control device which regulates the speed of a Varidrive in response to a signal. The signal is obtained from a standard type of pneumatic instrument sensitive to such variables as:

Temperatures	Liquid Level
Humidity	Weight
Pressure	Tension
Speed	Position

Many firms are increasing productivity with Varitrol control. Quality of product is improved, human effort is reduced. Lower costs result in better salability of your products.

U. S. Engineers are experienced in variable speed problems, and can help you apply Varidrives to your process.

Request new Bulletin on Varidrives with Varitrol automatic control. Indicate if you would like additional literature on Varidrives.

REQUEST FOR VARITROL BULLETIN

U. S. ELECTRICAL MOTORS INC. IA-10
Box 2058, Los Angeles 54, Calif. or Milford, Conn.

☐ Send also 16-page 4-color Booklet on Varidrives

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LEWIS Complete Temperature Measuring Systems for Aircraft

. . . Sturdy
. . . Accurate

Hermetically Sealed TEMPERATURE INDICATORS TO MILITARY SPECIFICATIONS

THERMOCOUPLE THERMOMETERS
STANDARD RANGES FOR CYLINDER, BEARING OR EXHAUST TEMPERATURES

2" SINGLE INDICATORS WITH MOUNTING BEZEL

2¼" DUAL INDICATORS

2" SINGLE INDICATORS FOR RING CLAMP MOUNTING

RESISTANCE THERMOMETERS
STANDARD RANGES FOR CYLINDER, OIL, FREE-AIR, COOLANT, CARB-AIR OR HEATING DUCT TEMPERATURES.

2" SINGLE INDICATORS WITH MOUNTING BEZEL

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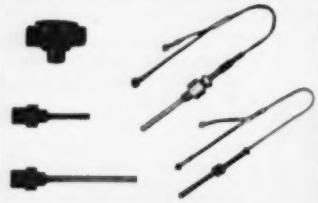
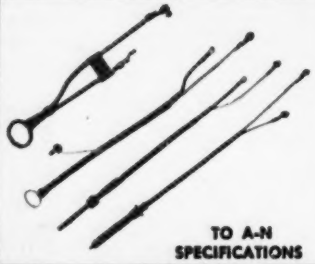
RESISTANCE BULBS • **THERMOCOUPLES** • **THERMOCOUPLE WIRE**
STURDY . . . FAST-ACTING — ACCURATE . . . RELIABLE — AIRCRAFT QUALITY . . . FROM OUR OWN WIRE MILL



A-N, FREE-AIR, STUFFING-GLAND AND CYLINDER-HEAD BAYONET TYPES



TO A-N SPECIFICATIONS

CHROMEL-ALUMEL — COPPER-CONSTANTAN

IRON-CONSTANTAN — TO A-N AND MILITARY SPECIFICATIONS

TO INSURE ACCURATE, RELIABLE TEMPERATURE INSTRUMENTATION, USE LEWIS BULBS, THERMOCOUPLES, LEAD WIRE, FIREWALL BLOCKS, RESISTORS AND INDICATORS

THE LEWIS ENGINEERING CO.
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Manufacturers of Complete Temperature Measuring Systems for Aircraft

For more information circle **13** on inquiry card.

Trends...

Instruments and AUTOMATION

Trends at First International Automation Exposition: Increased use of monitoring, scanning, telemetering and, particularly, digital readout. Digital displays were shown with "Inditrons," "Trochotrons," "Scoreboard" readout, "E1T" decade counters, coded lights, beam-switching tubes, edge-lighted engraved-plastic numbers, mechanical counters, automatic typewriters, automatic printers, etc.; also increased emphasis in electric and hydraulic valve operators.

Plastic pipe market has been expanding rapidly for years—from 5-million-pound resin consumption in 1951 to an expected 50-million-pound consumption in 1960. Report on pioneer use in instrument-air service (see page 1614) may expand this important market.

Nondestructive testing is expanding. This includes X-rays, radioisotopes, ultrasonics, magnetism, penetrant fluids, and electric energy. Use in early stages of production processes is becoming more necessary to prevent losses in automated manufacturing processes.

Population of U.S. will climb to estimated 177 million by 1960.

Privately-owned atomic power plants will compete successfully with conventional power plants in 5 to 10 years, says F. K. McCune, GE official. Recent GE report estimates one type of nuclear power plant to cost $195 per kw. capacity; another type $215 per kw. capacity. Conventional plants cost about $125/kw. First commercial nuclear power plant has been started by Duquesne Light Co., Pittsburgh.

About one fourth of all American engineering and scientific manpower, and about $2-billion dollars annually, is devoted to industrial research.

Highlights of an expanding industry: Gulton Industries adds 6000 sq. ft. to Metuchen plant; Electronic Engineering Co. of Calif. shows 87% increase in net profits for 1st 6 months of 1954; Burroughs Corp. establishes new Computer Section; Robertshaw-Fulton opens new $1-million research center at Irwin, Pa., and has started construction of $2-million plant at Milford, Conn. for Bridgeport Thermostat Div.; Electro Development Co. of Calif. plans 52,000-sq.-ft. expansion; Detectron Corp. forms new Computer-Measurements Div.; Foxboro opens new 15,000-sq.-ft. plant in Pittsburgh, Pa.; Federal Telephone & Radio announces new Instrument Dept. for manufacture and distribution of electronic and industrial instruments; Mason Instrument Co. of New Rochelle, N. Y. is new instrument manufacturer; Assembly Products moves into larger plant at Chagrin Falls, Ohio; Ramo-Wooldridge has started new 150,000-sq.-ft. facility in Los Angeles; Brush Electronics has purchased Digital Instrument Co. of Coral Gables, Fla.; Hazatrol Corp. establishes new plant at Palo Alto, Calif.; U. S. Relay opens new Shelf Projects Laboratory in Los Angeles; Burroughs Corp. purchases Haydu Bros.; Minneapolis-Honeywell has purchased Heiland Research Corp.; Bristol Co. has been purchased by American Chain & Cable Co.; Panellit, Inc. has affiliated with Taller & Cooper.

INSTRUMENTS ON THE MARCH

New Principles, Applications, Non-commercial Developments

Radio Sextant

CEDAR RAPIDS, IOWA.—Although many navigation aids are in general use, the basic navigation instrument is the sextant. Announcement has been made of a significant new development that represents an advance in navigation history—a radio sextant that automatically and continuously determines the sun's position by reception of microwave energy emitted by the sun.

Developed by Collins Radio Co. for the Navy Bureau of Ships, the radio sextant already has undergone operational tests. A radar-like antenna scans in a circle around the sun's rim. If the axis of rotation of the antenna is not pointing exactly at the center of the sun, the received signal (microwave energy emitted by the sun) is modulated at the scanning frequency. Phase-sensitive detectors derive error voltages that make the antenna track the sun precisely.

For use when the sun is near the horizon, the refraction of the radio energy by the atmosphere must be known; this is now being investigated. For use at night, experiments are underway to indicate the feasibility of tracking the moon.

Isotope-activated Markers

NEW YORK, N. Y.—Strontium-90-activated markers, developed by the U. S. Radium Corp. as a substitute for radium-activated personnel and identification markers, are reported to have (1) completely shielded primary radiation, (2) useful life and brightness level from 5 to 25 times that of radium units, (3) complete range of colors from blue to red. Other markers activated by thallium-204, prometheum-147, carbon-14, and hydrogen-3 are in industrial application in instrument illumination, photocell activators, etc.

Analog Computation Laboratory

PASADENA, CALIF.—The Miller "MILAC" Analog Computer is now available on a rental basis for solving a wide variety of general industrial and engineering problems. The service is offered through the MILAC Computer Laboratory in Pasadena, Calif., and is particularly valuable to organizations faced with analyzing a dynamic system on a point-by-point calculation basis but whose continuing engineering load does not justify purchase of a computer.

Typical problems solved on the MILAC Analog Computer and at the MILAC Computer Laboratory include: flutter analyses, stress studies, instrument servo analyses, studies of automotive riding qualities, earthquake structural studies, power-distribution studies, process-control design, engine simulation, and turbine vibration problems. Address inquiries to MILAC Computer Laboratory, Wm. Miller Instruments, Inc., 325 North Halstead Avenue, Pasadena 8, Calif.

Film-negative Restorer

SCHENECTADY, N. Y.—Development of a liquid which matches the physical and optical properties of film, and which hence can be used to fill the valleys formed by scratches, is announced by General Electric Co., Schenectady. The material, called "Refractasil," permits the production of salon-type prints, even though negatives are scratched. Film-handling techniques can also be made less precise. The liquid will soon be available from General Electric Co., Silicone Products Dept., Waterford, N. Y. A "Refractamatic 35" film holder will also be available from Simmon Bros., Inc., Long Island City, N. Y.

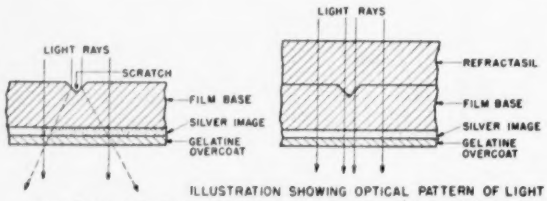
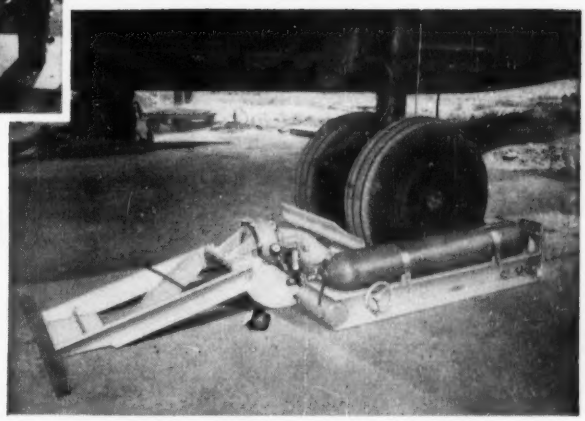


ILLUSTRATION SHOWING OPTICAL PATTERN OF LIGHT RAYS PASSING THROUGH 35 MM FILM WITHOUT AND WITH REFRACTASIL

Digital Computer at JPL

PASADENA, CALIF.—The Jet Propulsion Laboratory of California Institute of Technology has completed installation of this ElectroData Corporation electronic digital computer, a general-purpose data-processing instrument. The computer will be used in processing the mountains of numerical data generated by the laboratory's test cells and wind tunnels.

The magnetic-drum memory of the computer can remember 4,080 ten-digit words. A word from the quick-access section of the memory can be obtained in 0.0085 sec.;



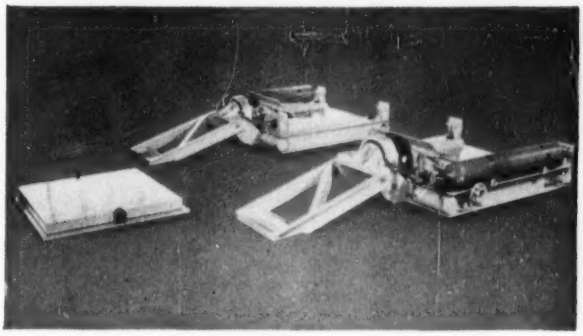
"GO" or "NO GO"

Thrust stands equipped with Hagan ThrusTorq units deliver direct, accurate readings of the actual performance of the plane engines under test. The pneumatic signals actuate indicators or recorders, either at the stand or remote, so that test personnel know instantly whether it is "go" or "no go" for the plane under test.

The portable stand, shown in the center and bottom photographs, requires only stop pieces bolted to the apron. The right and left wheel stands have their own supply of bottled nitrogen, used as a power source for the Hagan ThrusTorq. The stands can be set to suit the span of the landing gear. This stand measures a total thrust up to 25,000 pounds.

Maximum capacity is determined by the number and size of Hagan ThrusTorq units used in the assembly.

The Hagan ThrusTorq unit is fast, economical and clean. It is also used for thrust measurement of rocket and jet engines, and cradle dynamometer measurement of aircraft engines.



Complete Portable Thrust Stand, showing nose wheel unit and thrust measuring units in relative operating positions.

HAGAN
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BUROMIN
CALGON

Hagan Corporation

AERONAUTICAL AND SPECIAL PRODUCTS DIVISION
HAGAN BUILDING, PITTSBURGH 30, PA.

CONTROL SYSTEMS FOR AUTOMOTIVE AND AERONAUTICAL TESTING FACILITIES
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
BOILER COMBUSTION CONTROL SYSTEMS

For more information circle **14** on inquiry card.

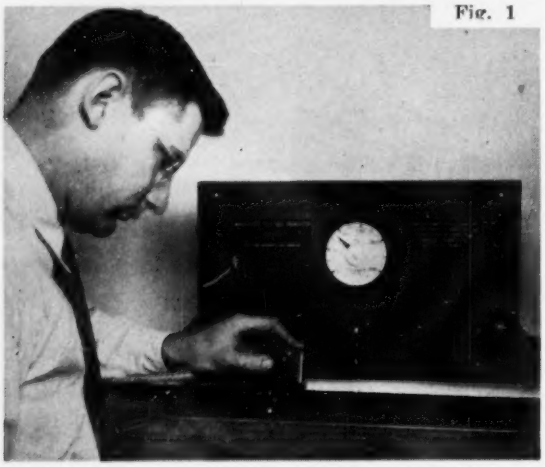
access to the main part of the memory drum requires 0.085 sec.

The computing system includes computer, photoelectric tape reader, tape punch, automatic electric typewriter, power supply, and control console.

Electronic Thickness Gages For Metallic Coatings

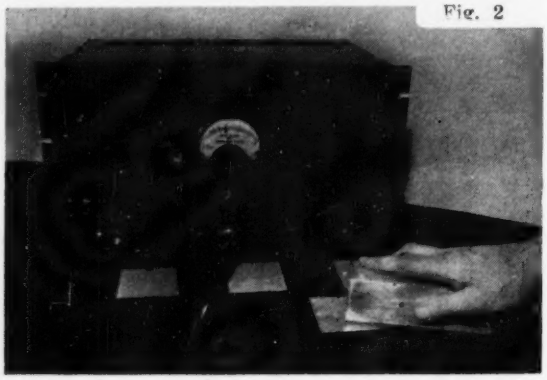
WASHINGTON, D. C.—The National Bureau of Standards has recently developed three types of instruments for measuring the thickness of electrodeposited coatings. While all three instruments depend upon the difference in electrical conductivity between the plating and the basis metal, each makes use of different methods for sensing specimen resistance. Two of the instruments (the "Dermitron" and the Phase-Angle Thickness Meter) utilize electromagnetic coupling to the specimen, making use of the reflected field from eddy currents induced in the specimen. A third, a waveguide inspection tool, employs direct conductivity measurement with a point electrode. All three devices permit simple nondestructive determination of plating thickness or of sample thickness for homogeneous metals. When calibrated, they can be used for measurement of magnetic as well as non magnetic materials.

Fig. 1



The "Dermitron" (Fig. 1) senses the reflected flux in a single coil excited with high-frequency current when it is close to the specimen. The probe coil is small and is held in physical contact with the sample. Its miniature size makes it possible to measure plating thicknesses of small specimens and sharply-curved surfaces.

Fig. 2



The Phase-Angle Thickness Meter (Fig. 2) relies on the measurement of reflected electromagnetic field with a separate pickup coil. For this it requires a somewhat more complicated circuit. Through a bucking transformer arrangement a voltage is derived whose phase shift is a direct function of the specimen conductivity. Measurement of phase change thus provides a means to indicate plating thickness. Originally developed for the rapid, continuous measurement of the thickness of silver plating on such large areas as stainless-steel waveguides, it offers insensitivity to variation in probe-to-sample spacing. With suitable calibration, the instrument can also be used on mag-

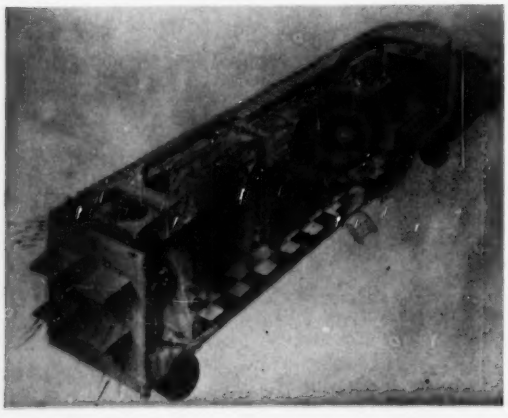
DYSEAC NBS Computer

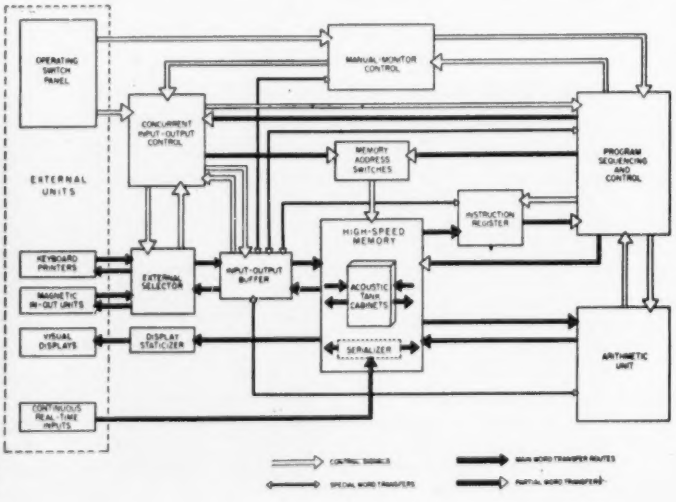
WASHINGTON, D. C.—A new high-speed digital computer, called DYSEAC, has been developed by the National Bureau of Standards and delivered to the Signal Corps for special application. Circuit techniques similar to those in the NBS SEAC were used—performance of all logical operations by diode gating, use of electrical delay lines for pulse storage, and use of transformer-coupled pulse amplifiers. The initial memory capacity of 512 words can be increased to 4096 words by additional storage units.

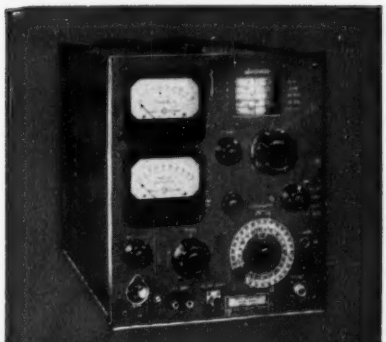
The main function is as a data-processing center for analysis of data-communication networks, monthly business accounts, air-traffic control, control of automatic machinery, etc.

(Below) Signal Corps mobile high speed digital computer.

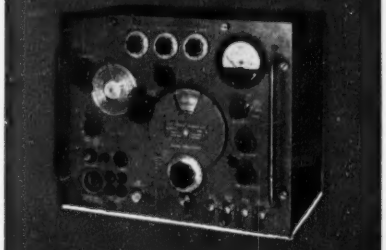
(Right) Schematic of DYSEAC.



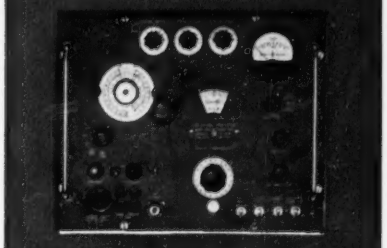




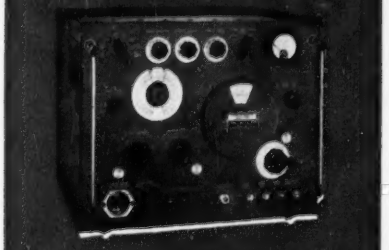
-hp- 608A VHF Signal Generator



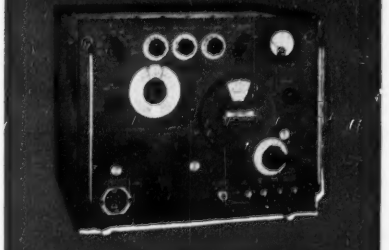
-hp- 614A UHF Signal Generator



-hp- 616A UHF Signal Generator



-hp- 618B SHF Signal Generator

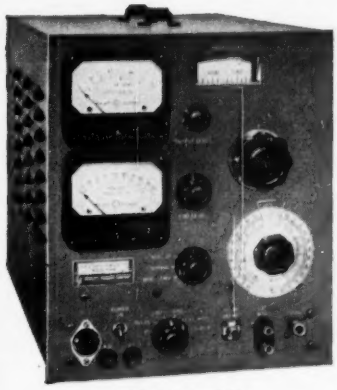


-hp- 620A SHF Signal Generator

Direct-reading, multi-purpose

SIGNAL GENERATORS

10 to 11,000 mc



-hp- 612A for UHF-TV

Hewlett-Packard offers six precision signal generators providing, collectively, direct-reading test signals from 10 to 11,000 mc. Whether you are measuring gain, selectivity, sensitivity, image rejection; driving bridges, slotted lines, antennas, filter networks; determining signal-noise ratio, SWR or transmission line characteristics, there is one of these wide range, high power instruments to answer the need. All have broadest usefulness, simple operation, wide modulating, pulsing and other output choices. Direct output calibration; no charts or tedious interpolation.

Only Hewlett-Packard offers this broad selection of direct-reading signal generators

Instrument	Frequency Range	Characteristics	Price
-hp- 608A	10 to 500 mc	Output 0.1 μv to 1 v into 50 ohm load. Pulse or CW modulation. Direct calibration.	$ 850.00
-hp- 612A	450 to 1,200 mc	Output 0.1 μv to 0.5 v into 50 ohm load. Pulse, CW or amplitude modulation to 5 mc. Direct calibration.	1,200.00
-hp- 614A	800 to 2,100 mc	Output 0.1 μv to 0.223 v into 50 ohm load. Pulse, CW or FM modulation. Direct calibration.	1,950.00
-hp- 616A	1,800 to 4,000 mc	Output 0.1 μv to 0.223 v into 50 ohm load. Pulse, CW or FM modulation. Direct calibration.	1,950.00
-hp- 618B	3,800 to 7,600 mc	Output 0.1 μv to 0.223 v into 50 ohm load. Pulse, CW, FM or Square wave modulation. Direct calibration.	2,250.00
-hp- 620A	7,000 to 11,000 mc	Output 0.1 μv to 0.071 v into 50 ohm load. Pulse, CW, FM or Square wave modulation. Direct calibration.	2,250.00

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hp

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Name_____

Company_____

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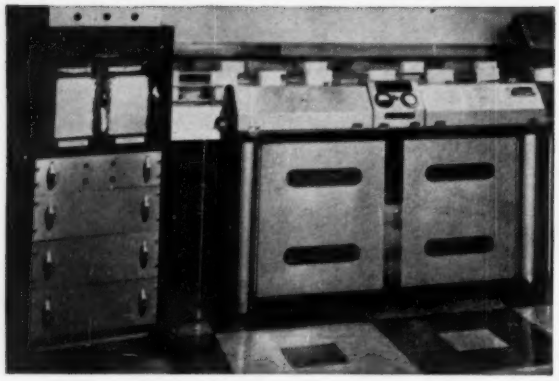

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Correct . . .

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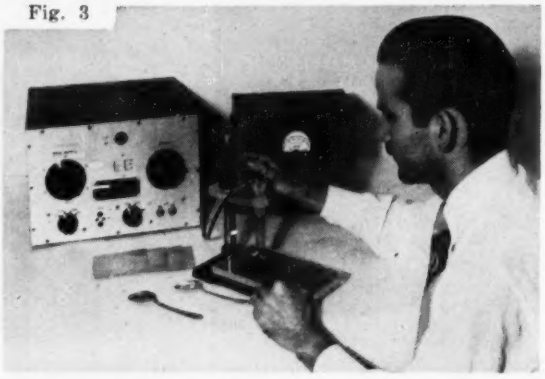
ON THE MARCH—CONTINUED

Fig. 3



netic materials, but probe-to-sample spacing must be controlled.

The Waveguide Plating Quantity Indicator (Fig. 3) was developed to permit measurement on both nonmagnetic and magnetic materials without change of calibration. The specific application was for use on waveguides having an intermediate layer of nickel of unknown thickness between the silver and stainless steel. In the instrument, a d-c. current is passed through the specimen, and the voltage drop across a known distance is measured. While the silver plating is on the inside of the waveguide, its effect on the d-c. conductivity measurement is the same as for outside plating. Thus the probe electrodes can be arranged to make contact on the outer surface, simplifying the measurement procedure.

Ultrasonics Controls Fuel Oil

PHILADELPHIA, PA.—Ultrasonic energy is used in a special monitoring system to automatically blend fuel oil for marine use, Minneapolis-Honeywell's Industrial Division here revealed recently. Reporting on the first successful field application of this new system, the engineers said it had "proved superior to conventional mixing procedures by accurately blending light and heavy fuel oil to conform to varying burner characteristics in different ships."

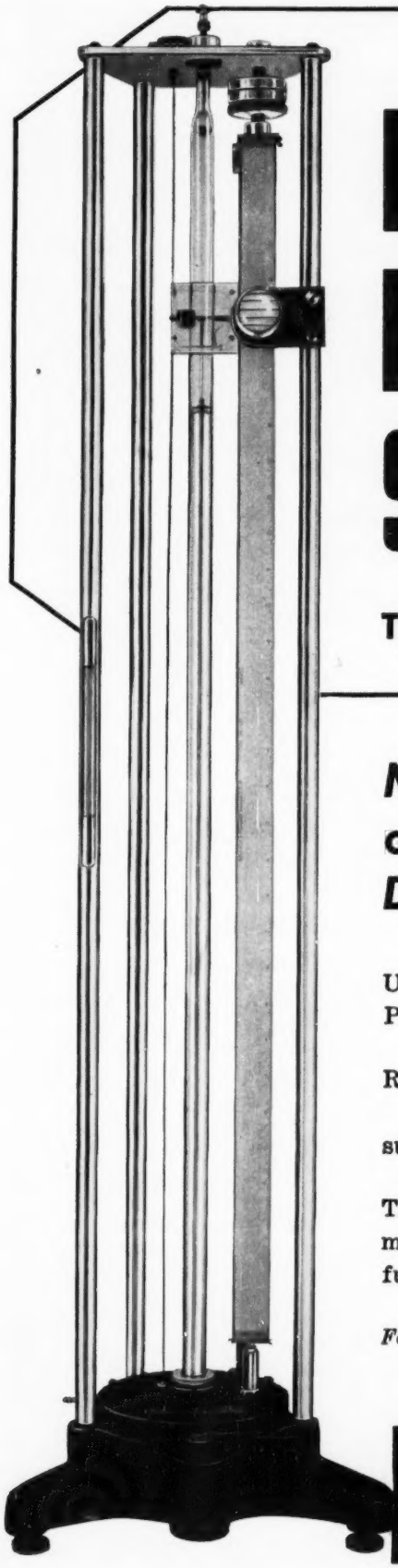
In the new technique, the viscosity of the fuel oil is measured by an "Ultraviscoson" unit (made by Bendix Aviation) which utilizes ultrasonic energy. As the viscosity varies, the information is fed to an electronic control unit developed by Honeywell which automatically controls the flow of light fuel oil to the mixture (by opening and closing a valve) to bring the viscosity to the predetermined desired value. Savings are expected from conservation of light fuel oil, which is worth considerably more than the heavy oil of the final blend itself.

Mayday—7HTAS

NEW YORK, N. Y.—Mrs. Tess Willis, wife of explorer William Willis of New York, has appealed to all radio operators to listen for signals of the explorer, who has not been heard from for over three months as his small raft tosses on the Pacific Ocean's Kon-Tiki route. Willis has been assigned an emergency frequency of 8364 kc.; he is scheduled to transmit daily at 11 A.M. and 6 P.M. EST. His call letters are 7HTAS. If his signal is picked up, please notify authorities of the Naval Hydrographic Institute, Washington, D. C.

Planetariums

PHILADELPHIA, PA.—Spitz Laboratories, Inc., of Phila., reports that the latest-model planetariums weigh only one-fifth of conventional and more-expensive installations. Much miniaturization was made possible by use of



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Type FA-187

Measures *Absolute* or *Differential Pressure*

Used interchangeably as a Barometer or Differential Pressure Manometer.

Range: 0 to 800 mm of Hg.
0 to 31.5 in Hg. or in any other desired pressure unit of equivalent range.

The magnetic vernier reads to 0.01 mm or 0.005 in. of mercury with an accuracy of 1 part in 5000 over the full range.

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CLIMATE-LAB

Humidity-Temperature TEST APPARATUS With Program Control

Widely used by industry and government for producing conditions required by U.S. Armed Forces for acceptance testing in accordance with various program schedules.

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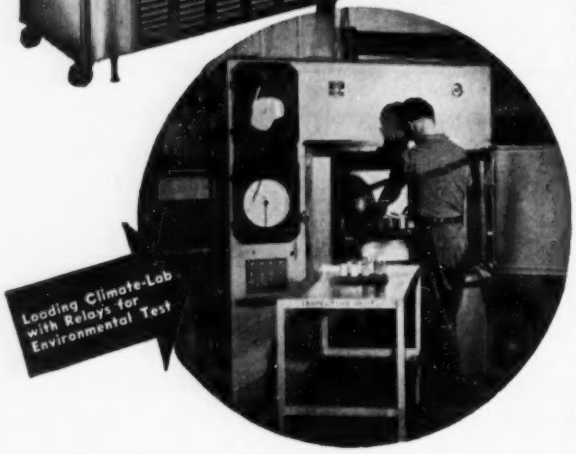
Equally adaptable to atmospheric corrosion studies, development and quality control.



The Climate-Lab is ideal for testing the performance and durability of materials and devices under specific climatic conditions. It consists of a test chamber, air-conditioning unit, and control system, all embodied in a compact unit which affords precisely controlled variations of humidity and temperature repeated periodically according to predetermined programs, and provides a chart record of these variations.

FOUR TYPES OF HUMIDITY-TEMPERATURE CONTROL

1. Constant humidity and constant dry-bulb temperature.
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4. Varying humidity and varying dry-bulb temperature.

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AMINCO Laboratory Instruments

AMERICAN INSTRUMENT COMPANY, INC.

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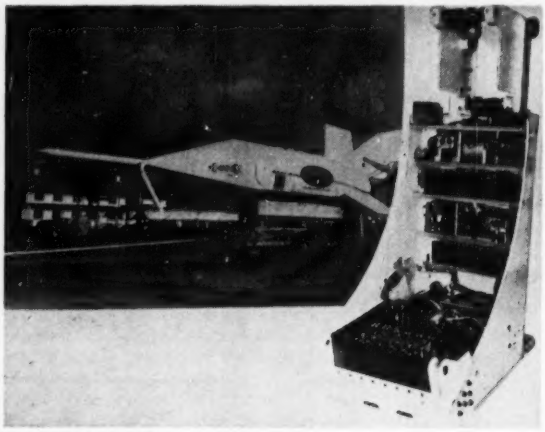
ON THE MARCH —CONTINUED

a tiny electric clutch made by Warner Electric Brake & Clutch Company of Beloit, Wis. The new small clutch controls the movement of the planetarium in all directions—north, south, east, and west. Constellations can be examined in positions of 100,000 years in the past or 100,000 years in the future. New uses for the small planetarium are for educational institutions and navigation instruction.

Instrumented Ejection Seat

DAYTON, OHIO—In project "Cherokee," study is being made of the simultaneous effects of deceleration, tumbling, and wind blast on ejection seats and cockpits of modern



high-speed military aircraft. The work is being done by Cook Research Laboratories, a Division of Cook Electric Company, Chicago, for the Aero Medical Laboratory, WADC, Dayton.

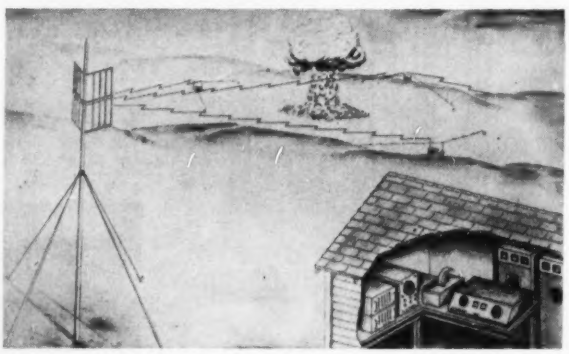
Illustration shows an air-launched rocket-propelled missile containing a fully-instrumented seat for recording all important variables on a Cook magnetic-tape recorder.

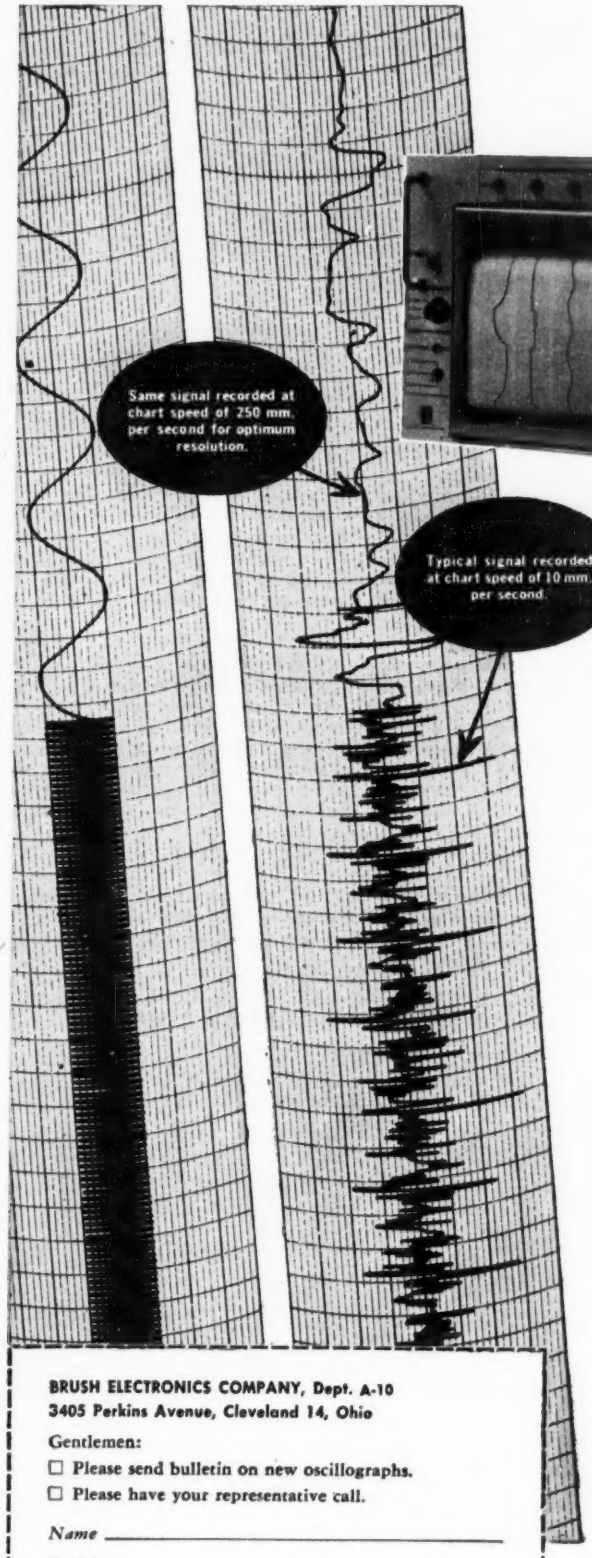
Radiation Monitor

WASHINGTON, D. C.—The National Bureau of Standards has developed a remote-control system which automatically measures radiation intensities and other variables in the vicinity of an atomic explosion and transmits the data by radio to a centrally located headquarters. Though developed for monitoring gamma radiation and weather conditions, it can be used with a wide variety of detectors to report many types of information.

An operator at the control station can select one of several data stations for transmission of data and determine what particular type of information is to be reported. The system is based on a ¼-watt portable transmitter-receiver and other standard equipment.

The radio link is an f-m. system operating between 162




Same signal recorded at chart speed of 250 mm. per second for optimum resolution.
Typical signal recorded at chart speed of 10 mm. per second.

New Brush Direct Writing Oscillographs

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From 10" per day to 10" per second

WITH THE NEW BRUSH 4- and 6-channel oscillographs you have a choice of up to 16 chart speeds—from 10 mm. per hour to 250 mm. per second. This permits excellent resolution of a great variety of signals—with economy in chart paper. From the various speeds available, you select the slowest speed that will give desired resolution of recorded signal.

The chart drive is electrically controlled; thus speeds can be changed instantaneously, from either local or remote locations. The high accuracy of the chart drive system provides a linear time base for all recordings at all speeds. With ink writing, the trace is uniform regardless of type of signal or chart speed. Electric writing is also available for unusual operating conditions.

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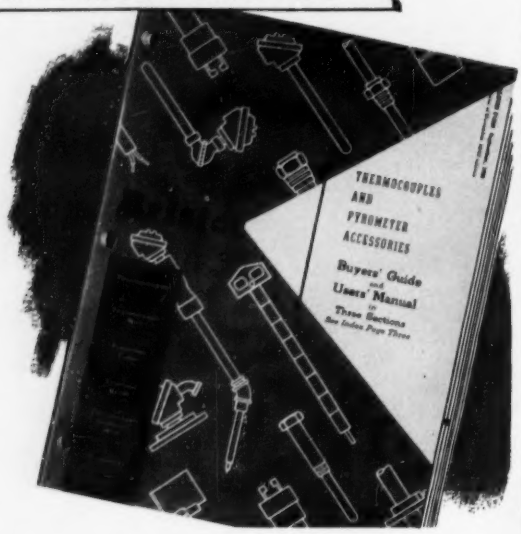
WHAT'S NEW AT BRISTOL...



Don't be without this free pyrometer reference book!

If you use pyrometers, this fact-filled 56-page booklet is a "must". Its three sections tell you quickly everything you want to know about thermocouples and all other pyrometer accessories.

Chock-full of money-saving ideas, informative illustrations, charts, and detail drawings, this well-indexed book does these three jobs:

HELPS YOU SELECT THE RIGHT THERMOCOUPLE, wire, and protecting tube for every installation. Complete information on all thermocouples and radiation pyrometers, with installation suggestions.

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ON THE MARCH—CONTINUED

and 174 megacycles. The link employs repeater stations located at positions of high elevation. Each repeater can handle information from 10 data stations, and each data station offers a choice of 10 different programs—each having several functions—which the operator can select for transmission to the control station.

The operator first "captures" a repeater station by an r-f. signal; the repeater then captures the data station. The data is then re-transmitted through the repeater to the control station.

Adoption Of International Nautical Mile

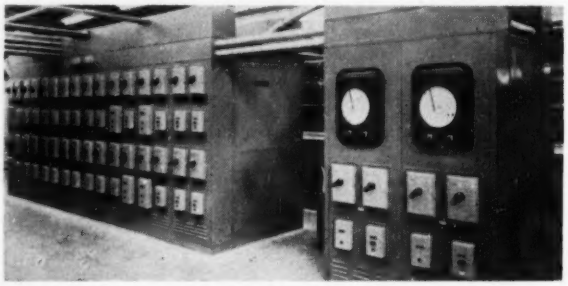
WASHINGTON, D. C.—Beginning on July 1, 1954, the National Bureau of Standards will use the International Nautical Mile in lieu of the U. S. Nautical Mile. This decision, replacing the U. S. nautical mile of 1853.248 meters (6080.20 feet) by the International Nautical Mile of 1852 meters (6076.10333 . . . feet), confirms an official agreement between the Secretary of Commerce and the Secretary of Defense to use the International Nautical Mile within their respective departments.

The use of a mile derived from the length of a degree of the earth's meridian is very old. It is believed that the Chaldean astronomers determined the length of such a unit. Miles of this sort have been variously called meridian miles, geographical miles, sea miles, and nautical miles, and they have differed greatly in magnitude, some of the values providing 10, 12, 15, and 60 miles to a degree. The British and the U. S. nautical miles were each derived by taking 60 nautical miles per degree, but the values adopted were not quite the same.

However, as a change feom 1853.248 meters to 1852 meters would not affect nautical charts, the calibration of navigational instruments, or navigation, the Departments of Commerce and Defense agreed to accept this value as of July 1, 1954, the announcement to be made by the National Bureau of Standards.

Viscosity Control System

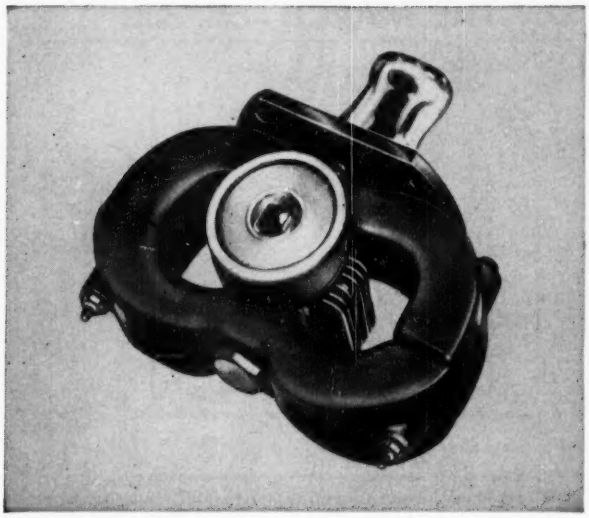
LOUISVILLE, KY.—The illustration shows a new flow-coating installation for electric range parts at the General Electric Plant in Louisville. Norcross Viscometers are used



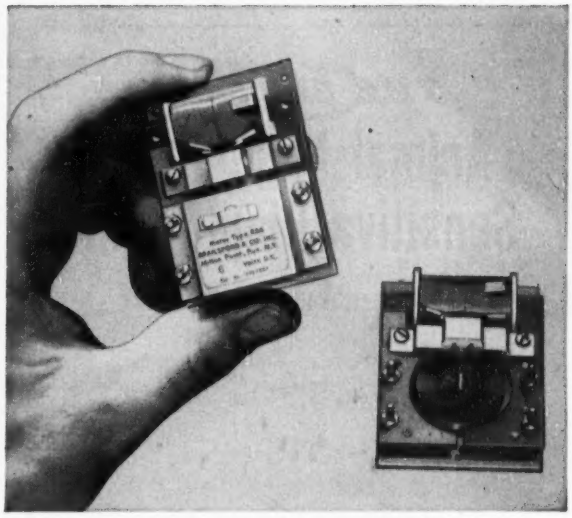
to automatically record the viscosity every 3 minutes; when it increases because of evaporation of the solvent the Viscometer opens a solenoid valve to add the necessary make-up solvent to very accurately maintain a constant viscosity. Accurate control of viscosity now makes it possible to use efficient flow coating where a good finish is required.

Rocket-engine Thrust

BUFFALO, N. Y.—Bell Aircraft Corp., Buffalo, measure the thrust of rocket engines by use of SR-4 load cells in a hinged test stand. Changes in electrical resistance of the strain gages in the load cells are transmitted to a recorder



Search Radar Magnetron Tube. Two large Carboloy Alnico permanent magnets supply the electron beam control in this Raytheon magnetron. They help reduce size and weight, with no decrease in performance.



Miniature Electric Motor. Tiny, powerful Carboloy permanent magnet replaces wound electromagnet as rotor. The magnet's self-contained power supply reduces battery drain, requires less power.

Permanent magnets provide an economical way to convert electrical energy to mechanical motion

Carboloy® Alnico permanent magnets provide a low-cost means of simplifying design and reducing size in motors, radar magnetron tubes and hundreds of other products.

In the motor above, a tiny Carboloy permanent magnet rotor supplies the motor action; in the magnetron tube, two large Carboloy permanent magnets provide electron beam control. Both are examples of permanent magnets' inherent ability to convert electrical energy to mechanical motion. Thousands of other products utilize Carboloy permanent magnets' other basic functions (see below) . . . and realize substantial cost and design savings.

Permanent magnets supply a uniform source of stable, low-cost energy; help eliminate coils, wire and other operating parts. They are available cast, or sintered where closer tolerances and more complex shapes are required.

"Designing-in" permanent magnets will improve your product. Specially trained Carboloy Magnet Engineers will work with you in both design and application. Send coupon today, for complete information and technical literature.

Basic functions of permanent magnets

1 Convert electrical energy to mechanical motion
- Eddy Current Braking
- Instrument Action
- Motor Action
- Acoustic Action
- Electron Beam Control

2 Convert mechanical motion to electrical energy
- Generator Action
- Magneto Action
- Sound Pick-up

3 Convert mechanical energy to thermal energy
- Control of Torque

4 Mechanical Holding
- Snap Action
- Separation
- Holding and Lifting

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I would like the following:

Information on permanent magnets in _____

☐ Permanent Magnet Design Manual, PM-101

☐ Permanent Magnet Standard Stock Catalog, PM-100

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Animal Membrane Sensitive Diaphragm

Patent Nos.
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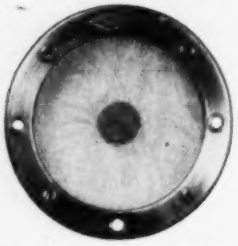
2466658
Canada
457125



Patent Nos.
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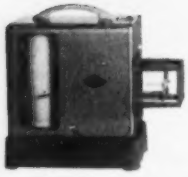
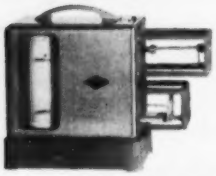
Heart of Serdex Hygrometric Instruments that over the years have demonstrated their ability to accurately indicate and/or record Relative Humidity over the full range of the scale, with minimum lag.

LABORATORY STANDARD INDICATING HYGROMETER
Type HGS. HY. 1



MYCROHYGROGRAPH
Type HGS. MHY. 1



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Serdex instruments are unqualifiedly guaranteed as to accuracy for one year.

We are proud of our ability to give this guarantee—it has accompanied every instrument bearing our name and is unmatched in this field of instrumentation. There must be a reason.

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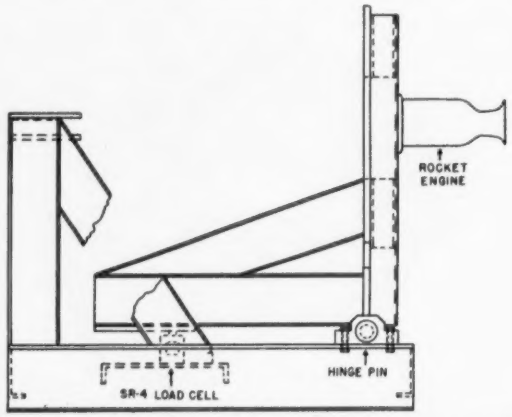


500-feet away. For calibration, horizontal loads are applied mechanically or hydraulically to the vertical arm through a calibrating load cell on the centerline of the rocket engine.

ORNL Research Reactor

OAK RIDGE, TENN.—A new high-flux reactor for fundamental research and engineering studies will be constructed at the Oak Ridge National Laboratory, at a cost of about $2,800,000.

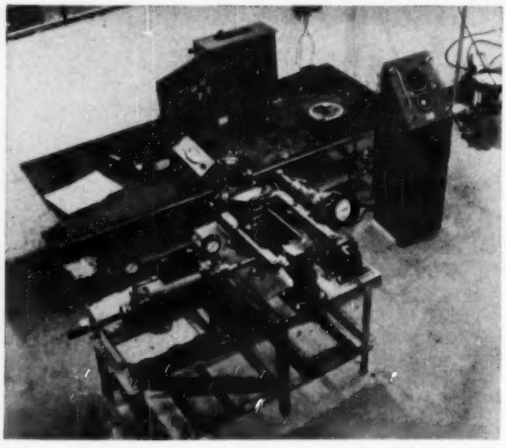
The reactor will have a heterogeneous core with enriched uranium as fuel. It will use ordinary water as a moderator and coolant, and will operate at a power level of five megawatts of heat.

The reactor will provide an average thermal neutron flux of 3.3×10^{13} neutrons per square centimeter per second and an average fast flux of 1.6×10^{13} neutrons per square centimeter per second. These fluxes are about twice those or ORNL's low-intensity Test Reactor and one-sixth the fluxes of the Materials Testing Reactor at the National Reactor Testing Station.

Architect-engineering work will be by subcontract under Union Carbide and Carbon Corp., which operates the Laboratory for the Commission.

Cybernetic (Steersman)

PATERSON, N. J.—The recently-developed Bogue Automatic Ship's Steering Mechanism, the first fully automatic



device for steering large ships, compensates for wind and current. A 1/10-microwatt signal from the gyro produces a 5,000-inch-pound torque on the rudder. Shown are the steering stand and the rotary hydraulic actuator. The device is made by Bogue Electric Mfg. Co. of Paterson.

Arnold O. Beckman INC.

OXYGEN ANALYZERS

For Industry - Medicine - Research

Operating on the unique paramagnetic (attracted into a magnetic field) property of oxygen, these instruments provide many unique advantages . . .

SELECTIVITY:

Highly sensitive to oxygen. Effects of gases other than oxygen are negligible.

MANY RANGES:

Full scale ranges from 0-1000 PPM or up to 0-100% O_2 available. Combustion ranges 0-5, 0-10, 0-15% O_2 supplied with 0-25% O_2 air check range. Multi-range instruments available.

HIGH ACCURACY:

1% of full scale (Example: ±0.05 on range 0-5% O_2) for industrial and laboratory instruments.

RAPID ANALYSIS:

A 95% response is obtained in 45 seconds with standard instruments... with special instruments in 7 seconds!

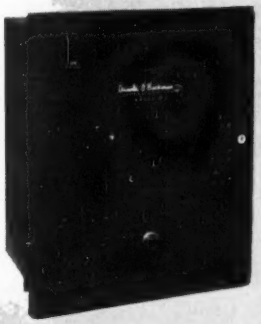
VERSATILITY:

Instruments designed for portability, recording, indication, explosion-proof operation and equipped with many other desired features are available.

Model D

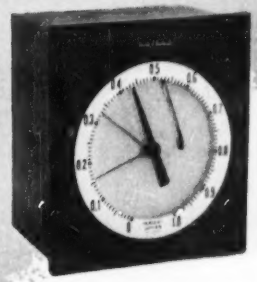
Model C

Model E-2



Model F-3

Model G-2



Get the full story on the valuable ways Arnold O. Beckman Oxygen Analyzers can benefit your operations and increase your profits. Write for Data File 6G-104!

Arnold O. Beckman INC.

1020 MISSION ST., SOUTH PASADENA, CALIFORNIA

For more information circle **23** on inquiry card.

Books...

Instruments and AUTOMATION

INSTRUMENTAL ANALYSIS

J. H. Harley and S. E. Wiberley

John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 1954. Cloth, 440 pages, $6.50.

Twenty-two chapters, undergraduate level, cover operation of major analytical instruments and application of these instruments to research problems. Contains commentary on systems of terminology and many references from recent journal articles.

INTRODUCTION TO COLOR TV

M. Kaufman and H. Thomas

John F. Rider Publisher, Inc., 480 Canal St., New York 13, N. Y. 1954. Paper, 140 pages, $2.10.

Six chapters, non-technical, treat fundamentals of color for television, NTSC color system, tricolor picture tubes, and adjustment of receivers. Contains glossary of common terms used in color television.

TEMPERATURE MEASUREMENT IN ENGINEERING, VOL. 1

H. D. Baker, E. A. Ryder and N. H. Baker

John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. Cloth, 179 pages, $3.75.

Thirteen chapters, non-mathematical, cover methods of measuring temperature, precision requirements, conditions affecting measurement, thermocouple thermometer-circuits, indicating instruments, installation design types, drilling technique, etc.

CHARACTERISTICS AND APPLICATIONS OF RESISTANCE STRAIN GAGES

Government Office, Washington 25, D. C., 1954. Cloth, 140 pages, $1.50.

Eleven papers presented at National Bureau of Standards symposium report on conducting coating applied by evaporation technique, special temperature compensated gages, gages for strain measurements beyond elastic range, and application of strain gages to determination of dynamic properties of materials and to measurement of large static forces.

APPLIED ELECTRONICS

Truman S. Gray

John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1954. Cloth, 881 pages, $9.00.

Undergraduate level, thirteen chapters cover: electron ballistics; electron emission from metals; electrical conduction through vacuum, gases and vapors; vacuum and gas tubes; rectifier and controlled-rectifier circuits; semi-conductor rectifiers and transistors; etc.

RADIO-FREQUENCY POWER MEASUREMENT

Roald A. Schrack

Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. Paper bound, 16 pages, $.15.

Comprehensive survey of methods used to measure radio-frequency power, classed according to theoretical origin. Includes theoretical background, practical limitations, advantages, comparative table and list of references.

ROTATING ELECTRICAL MACHINERY

Crow Universal Scientific Co., Inc., 1102 Shelby St., Vincennes, Ind., 1954. Paper, 256 pages, $3.50.

Two sections, non-technical, reduces theory, assembly and operation of 25 different d-c. and a-c. machines to simplest possible terms. Breaks each experiment down into discussion of theory involved, demonstration, step-by-step instructions for assembly and comprehensive pictorial review.

INTRODUCTION TO THE THEORY OF ERROR

By Yardley Beers

Addison-Wesley Publishing Co., Inc., Cambridge 42, Mass., 1953. Paper, 65 pages, $1.25.

Eight sections, technical, present classifications of errors, definitions, experimental error in measured quantity, propagation of error, special topics in adjustment of data, and statistical errors of nuclear physics.

CHAMBER'S SHORTER SIX-FIGURE MATHEMATICAL TABLES

L. J. Comrie

Chemical Publishing Co., Inc., 212 Fifth Ave., New York, N. Y., 1954 Cloth, 387 pages.

Collection of mathematical tables includes tables essential for general purposes requiring more than four-figure accuracy.

THE MEASUREMENT OF STRAIN

C. M. Hathaway

Hathaway Instrument Co., 1315 South Clarkson St., Denver 9, Colo., Paper, 20 pages, $.25.

Four parts, non-mathematical, cover importance of strain measurement, equipment needed, electric strain gage, measurement of static strain, and measurement of dynamic strain.

PRINCIPLES OF AUTOMATIC CONTROLS

Floyd E. Nixon

Prentice-Hall Inc., 70 Fifth Ave., New York 11, N. Y., 1953. Cloth, 409 pages, $9.35.

Fifteen chapters, graduate level, cover various principles utilized in design of automatic control systems. Includes applications of mathematics, Laplace transform, block-diagram notation, Nyquist criterion, types of compensation, and nonlinear systems.

ALTERNATING-CURRENT MACHINES, THIRD EDITION

By A. F. Puchstein, T. C. Lloyd and A. G. Conrad

John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1954. Cloth, 721 pages, $8.50.

Fifty-four chapters, undergraduate level, begin with transformers and show who how to understand, test, predict and calculate the behavior and performance of the most important classes of a-c. power machinery. Includes new material on loading polyphase transformers, adjustable speed drives, short circuit characteristics of alternators and rectifiers.

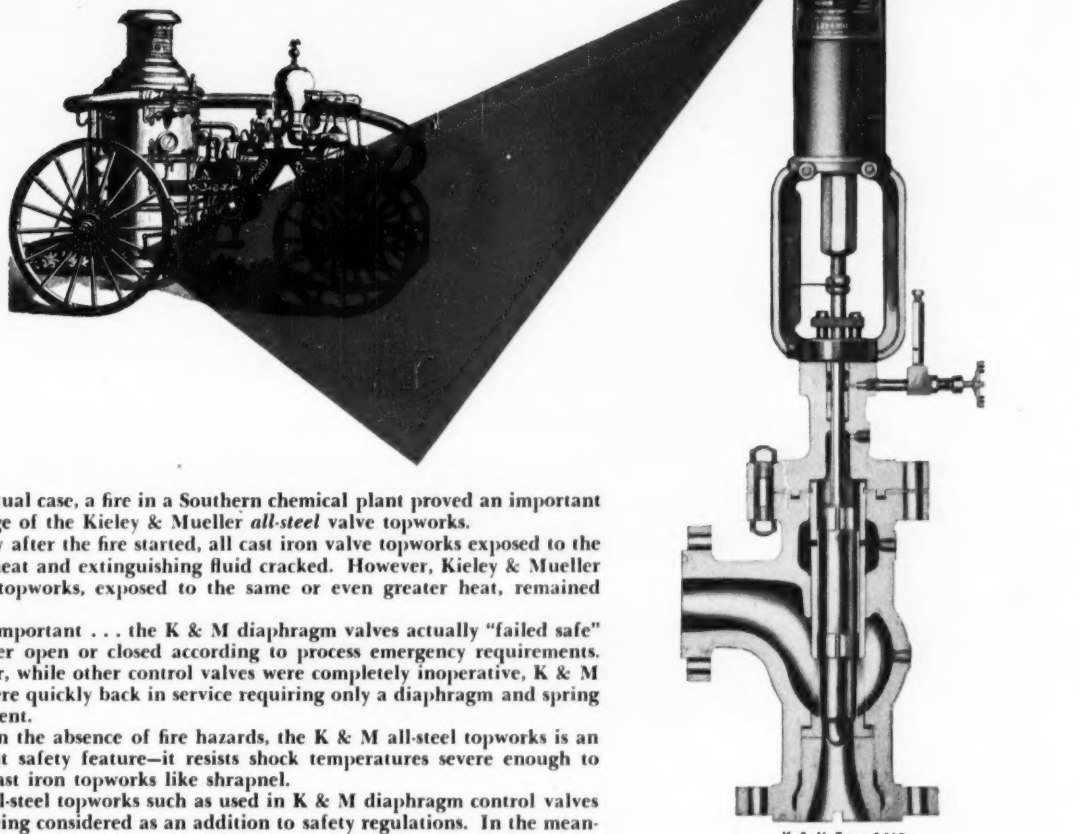
ENGINEERING ANALYSIS

D. W. Ver Planck and B. R. Teare, Jr.

John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1954. Cloth, 344 pages, $6.00.

Seven chapters, undergraduate level, discuss professional methods of dealing with engineering problems and their applications, understanding of principles fundamental to engineering, translation into mathematics, ordinary differential equations, and interpretation of mathematics.

in case of fire...
WHAT HAPPENS?



In an actual case, a fire in a Southern chemical plant proved an important advantage of the Kieley & Mueller *all-steel* valve topworks.

Shortly after the fire started, all cast iron valve topworks exposed to the intense heat and extinguishing fluid cracked. However, Kieley & Mueller all-steel topworks, exposed to the same or even greater heat, remained intact.

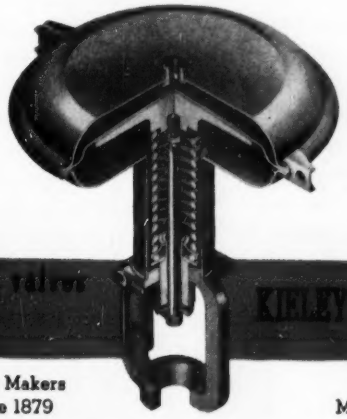
Most important . . . the K & M diaphragm valves actually "failed safe" . . . either open or closed according to process emergency requirements. Moreover, while other control valves were completely inoperative, K & M valves were quickly back in service requiring only a diaphragm and spring replacement.

Even in the absence of fire hazards, the K & M all-steel topworks is an important safety feature—it resists shock temperatures severe enough to shatter cast iron topworks like shrapnel.

The all-steel topworks such as used in K & M diaphragm control valves is now being considered as an addition to safety regulations. In the meantime, you can have this essential safety factor, along with all the other design advantages of Kieley & Mueller diaphragm control valves, such as the highest flow capacity and maximum linearity of response, at no additional cost.

FOR THE COMPLETE FACTS . . . write for the K & M Valve Engineering Data Catalog, Bulletin CV53.

K & M Type 1460
Sweep Flow Angle Valve
for slurries and flashing liquids



K&M

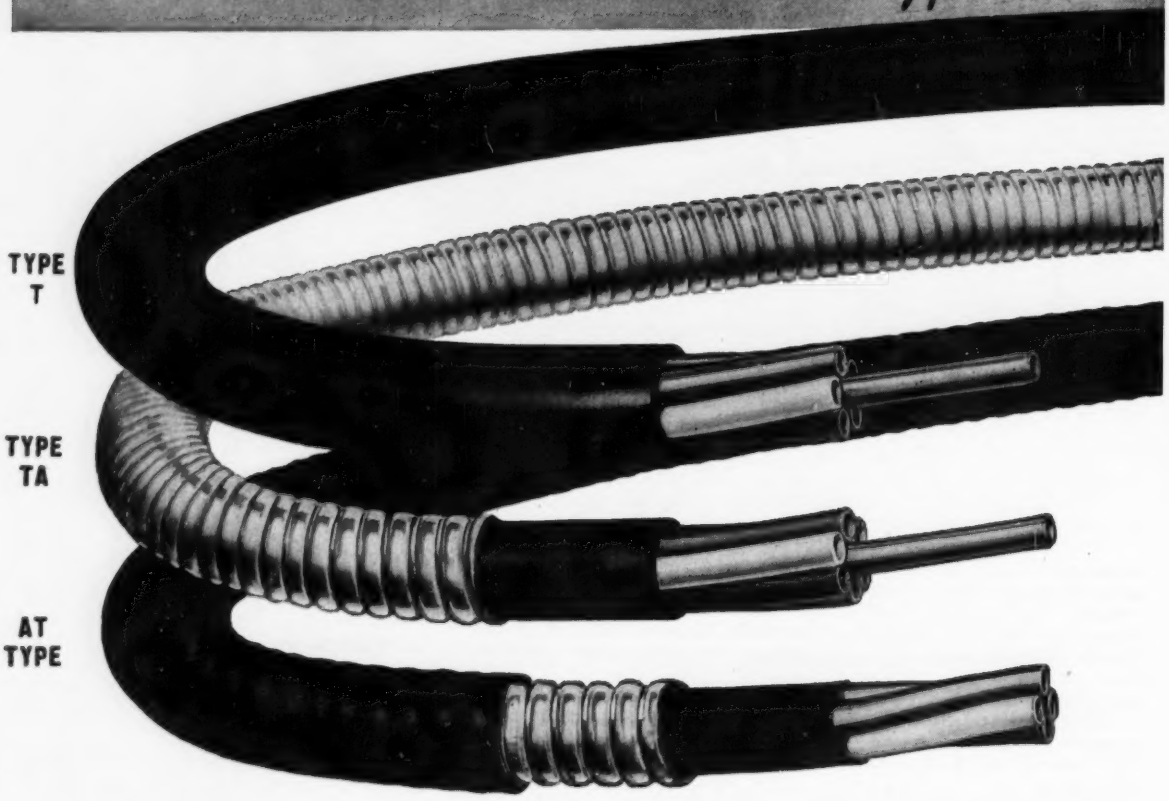
Valve Makers
Since 1879

64 Genung Street
Middletown, New York

For more information circle **24** on inquiry card.

CRESCENT ARMORED MULTITUBE

In 3 Corrosion Resistant Types



For Pneumatic and Hydraulic Instrument Controls

TYPE T—In damp or corrosive locations where a moderate degree of mechanical protection to the tube is required, as in troughs or attached to building surfaces or supporting means, the construction shown in top view is recommended. It employs a tough corrosion-resistant thermoplastic sheath, resistant to water, acids, alkalies, oils, most chemicals, and is flame-retardant.

TYPE TA—Where maximum mechanical protection is desired during or after installation, such as direct burial in concrete and pulling into conduit, an interlocked galvanized steel armor over the thermoplastic sheath, as shown in middle construction above, is recommended.

TYPE AT—For maximum protection against corrosion and mechanical injury to the tubing, the thermoplastic sheath is applied over the flexible steel armor as shown in the bottom construction illustrated above.

These forms also provide the other advantages possessed by CRESCENT ARMORED MULTITUBE which include permanence, lower over-all cost and ease of installation.

CRESCENT ARMORED MULTITUBE consists of long length tubes twisted together to permit bending without distortion. In each layer one tube is a bright blue color, affording a fast means of identification from both ends.

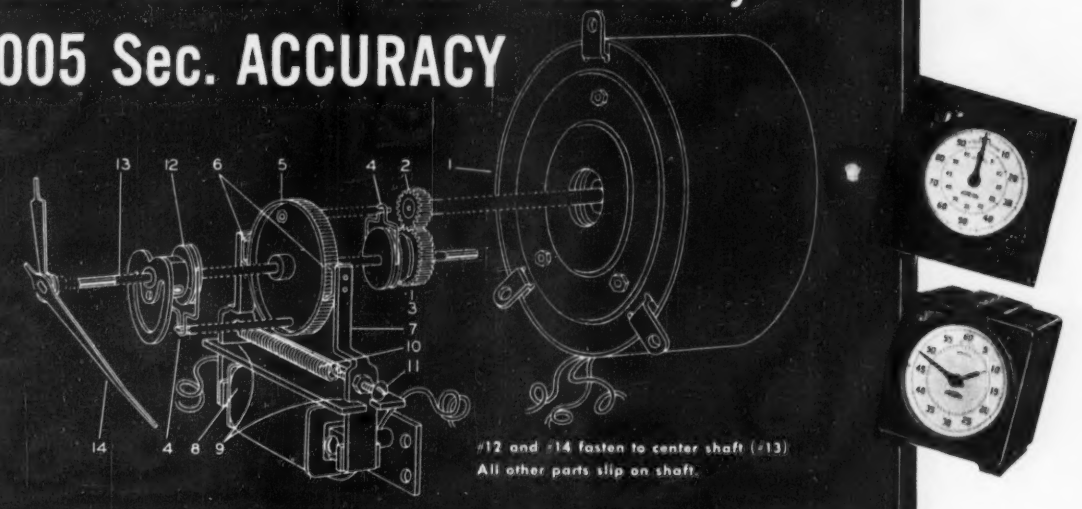
Available in long runs up to 1000 feet and up to 19 tubes of copper, aluminum or polyethylene tubing in size ¼" O.D. This product is licensed under U.S. Patent 2,578,280.

SEND FOR BULLETIN GIVING COMPLETE INFORMATION AND ENGINEERING DATA.

CRESCENT INSULATED WIRE & CABLE CO.
TRENTON, NEW JERSEY

For more information circle **28** on inquiry card.

Facts behind the S-1 Timer's extraordinary
.005 Sec. ACCURACY



Formula S-1 ***Expensive high torque, ball bearing motor, low inertia of moving parts, high proportion of precision and ground parts, no thrust bearings as found in ordinary clutches.***

● High torque (2 inch-ounce at 100 RPM) industrial grade motor (#1) with no internal gear train so small changes in load due to binds or hand acceleration cause no phase shift between rotor and rotating field . . . runs continuously to eliminate starting error.

● Precision cut gears (#2, #3). Any eccentricity or inaccuracies in gearing reflect directly in timer reading.

● Slip clutch composed of hardened steel spring (#4) riding a V-grooved graphited (for long wear) collet, applies .6 inch-ounces of torque to aluminum (for low inertia) control disc (#5) with 314 tiny teeth in its periphery.

● To hold control disc (#5) at rest, 2 hardened steel brake shoes (#6), ground to square knife edges, grip periphery of control disc in 4 places . . . control disc position to under ½ of a degree (1/720 second).

● Electro magnet (#8) pulls brake shoes away from control disc through armatures (#7). Air gaps kept to minimum for speed. Precision made fulcrums prevent stickiness or unequal movement of armatures.

● Adjusting screw (#11) adjusts tension of armature spring (#10) so that time between energizing magnet coil and starting of control disc is same as time between de-energizing magnet coil and stopping of control disc. This compensates for starting and stopping errors.

● Second friction clutch (#12) transfers control disc motion to center staff (#13); allows hands to be reset when control disc is held stationary.

"Gentlemen . . . Let me give you the formula for our astounding final accuracy of .005 sec. obtained with our D-C clutch S-1 Timer."

STANDARD SINCE 1884

To Split the Split Second with ACCURACY, Take a Minute Now and Send Us This Coupon

The STANDARD ELECTRIC TIME COMPANY

93 LOGAN STREET • SPRINGFIELD 2, MASS.

PRECISION TIMERS • PIPELINE NETWORK ANALYZERS
LABORATORY PANELS • CHRONO-TACHOMETERS

THE STANDARD ELECTRIC TIME COMPANY
93 Logan Street • Springfield 2, Massachusetts
Gentlemen: Please send me complete Engineering Data on the S-1 Timer.

Name_____

Firm_____

Street_____

City_____ State_____

For more information circle **26** on inquiry card.

WHERE RELIABILITY COUNTS AND DEPENDABILITY IS A MUST

The ingenious, simply-designed mechanism of Fisher Wizard Controllers provides extreme accuracy and dependability in pressure control.

Fisher Wizard Controllers will completely solve your pressure control problems. They are individually built to meet your exact operating conditions, and are guaranteed to give satisfactory performance.

High pressure Fisher Wizards are available in throttling and snap acting types. Bourdon Tube pressures from 5 to 5,000 P. S. I. Diaphragm or remote panel mounting.

Low pressure Fisher Wizards available in diaphragm or remote panel mounting. Bellows pressures from ½ to 15 P. S. I.

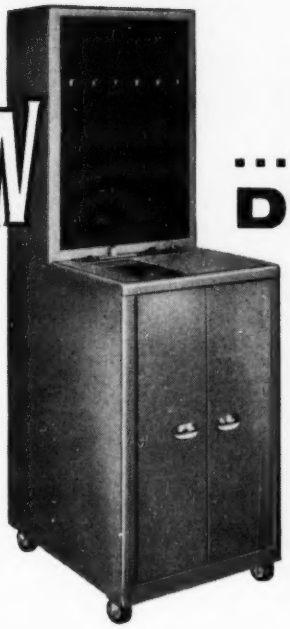
FISHER LEADS THE INDUSTRY IN RESEARCH FOR BETTER PRESSURE CONTROL

FISHER GOVERNOR COMPANY Marshalltown, Iowa

For more information circle **27** on inquiry card.

The new Type M Dynograph Recorder is a high speed direct writing oscillograph providing exceptionally high, absolutely stable, d-c or a-c amplification. It may be used with reluctance type pick-ups without auxiliary equipment. The exceptional stability, sensitivity, and versatility of the Dynograph allow simultaneous direct recordings of a very wide variety of transient variables such as temperature, speed, position, pressure, acceleration, vibration and strain.

The Type M employs individual plug-in amplifiers; and input panels provide all connections for various types of signal pick-ups. It is the most advanced equipment for your direct-writing recording problems.

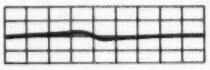


NEW ...OFFNER TYPE M DYNOGRAPH RECORDER

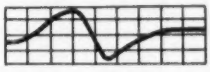
WHY THE DYNOGRAPH? For almost every application of direct writing oscillographs, those who have compared features of competitive instruments have chosen the Dynograph—because:

The Dynograph provides *thirty times* the d-c sensitivity of competitive instruments.*

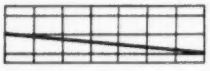
Instead of a barely readable record like this:



The Dynograph gives a large, easily read record like this:

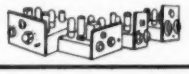


Yet while competitive recorders drift 1 mv per hour* or more—



The Dynograph is absolutely non-drifting.

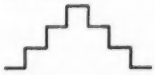
Other recorders require additional amplifiers or preamplifiers for moderate gain d-c; for high gain d-c; for carrier applications (strain gauges or reluctance bridges).



With the Dynograph, one amplifier covers all applications—and does a better job on each!

Pen friction and low torque gives hysteresis on many recorders.

There is no measurable hysteresis on the Dynograph.



Limited pen travel makes recording of large dynamic variations difficult.

Over 8 cm of pen excursion is available in the Dynograph.

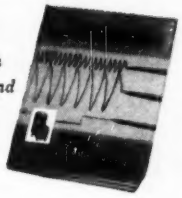
Even at moderate sensitivities, other assemblies require considerable warmup time for stabilization.

The Dynograph is stable as soon as it is working.

* Based on manufacturer's published claims.

COMPARE AND YOU WILL SELECT THE DYNOGRAPH

Eight page, 2 color bulletin describes technical details and application information. Write for your copy of Bulletin L-742.



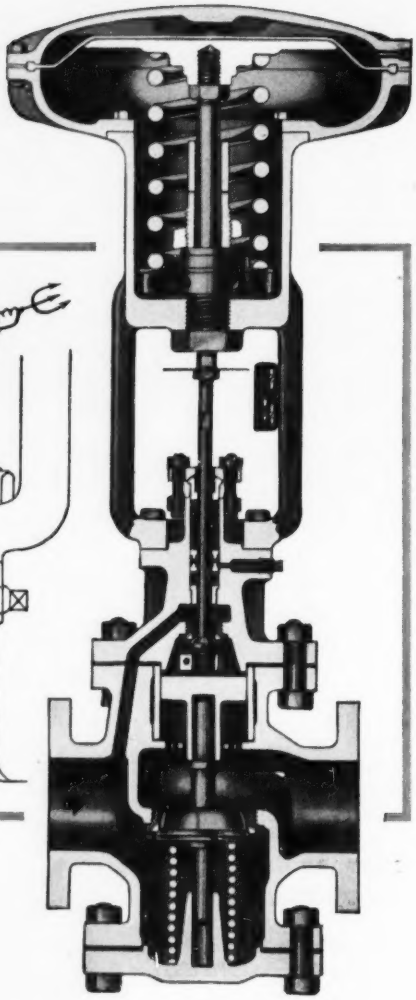
OFFNER ELECTRONICS INC.

5326 N. Kedzie Ave., Chicago 25, U.S.A.

For more information circle **28** on inquiry card.

PACKING PROBLEMS?

The new Leslie Lubrisoft® Packing now standard in all Leslie Diaphragm Control Valves is recommended for valve body temperatures up to 500° F. *without external lubrication.* When used with the Leslie thermo-isolating bonnet, it may be used for valve body temperatures up to 1050° F., eliminating need for external lubricators and isolating valves in most applications.



LESLIE LUBRISOFT® PACKING "BEATS THE DEVIL" OUT OF ALL 8 MOVING STEM SEAL PROBLEMS

Each of the several types of Lubrisoft split ring packing is specifically designed to maintain the low-friction stem seal against one or more of these deteriorative service conditions:

1. **Internal pressure, temperature and fluid**
2. **Contamination**
3. **Corrosion**
4. **Electrolytic Action**
5. **Oxidation**
6. **Extrusion**
7. **Abrasion**
8. **Friction**

Overall result is a standard, economical packing, with superior stem sealing properties and long service life. Precision fabricated to conform exactly to the deep stuffing box dimensions, the positive, split ring design makes fast replacement possible, without disturbing body or stem adjustment.

Plan to reduce control valve maintenance costs by sending for Bulletin 5304 Diaphragm Control Valves.

LESLIE CO., 299 GRANT AVENUE • LYNDHURST, NEW JERSEY

LESLIE VALVES

"STILL FAR AHEAD IN QUALITY AND PERFORMANCE"

2018A

For more information circle **29** on inquiry card.

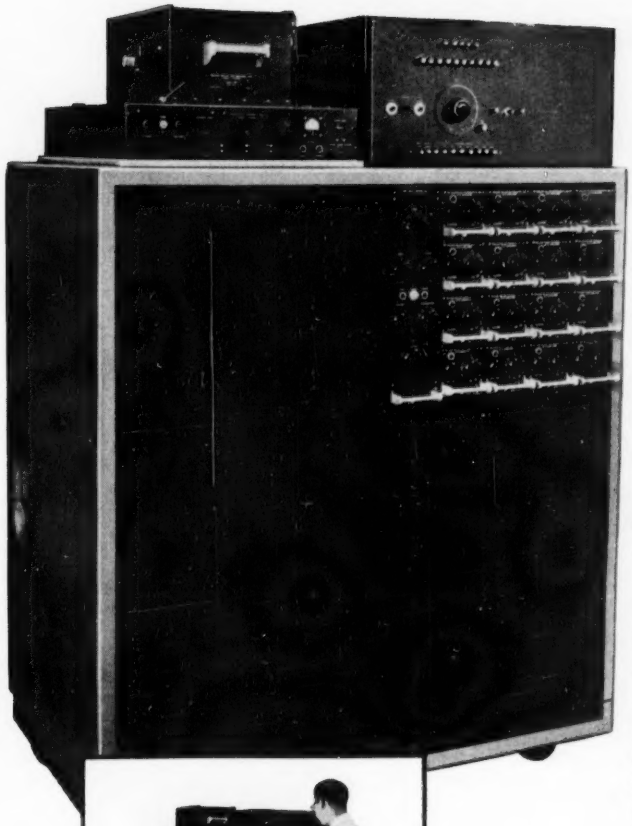
Not just a new model....but

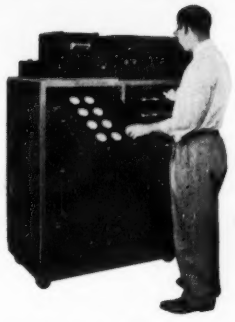
A NEW CONCEPT

in

recording

oscillographs





Optically flat cathode-ray tubes are conveniently rack mounted for single-sweep photography and adjustment.

Now ... Wm. Miller Instruments, Inc., pioneer designers and builders of galvanometer-type recording oscillographs, offers the first significant basic advance in multi-channel recording in over a decade. The new Miller CR-1 Cathode-Ray Recording Oscillograph, a *complete* instrument system in a single cabinet, breaks through the "5-kc Barrier" and makes it possible to record up to 16 separate channels at frequencies as high as 50,000 cycles per second. Chart speeds up to 400 inches per second and a patented Miller Optical System combine to provide excellent resolution and clearly readable, permanent records.

Self-contained, highly stable power supplies, preamplifiers, amplifiers and recorder make the CR-1 a convenient, ideal solution to many of today's — *and tomorrow's* — research and development problems. Its key features include:

- 16 time-synchronized channels on 8" photographic record.
- Continuous recording of phenomena as high as 50,000 cps; single-sweep photography as high as 250,000 cps.
- Record speeds from 3" to 400" per second through push-button controls; record lengths to 300 feet.
- High-precision system for 1/10, 1/100 and 1/1000-sec. timing lines.
- Automatic record-identification and reference trace recording.
- Unusual ease of operation—simplified, individual controls for all channels.
- Integrated, single-cabinet construction—portable, accessible.

Complete information on the CR-1's operation, characteristics and construction will be sent promptly. Write to our Pasadena office:

WM PASADENA

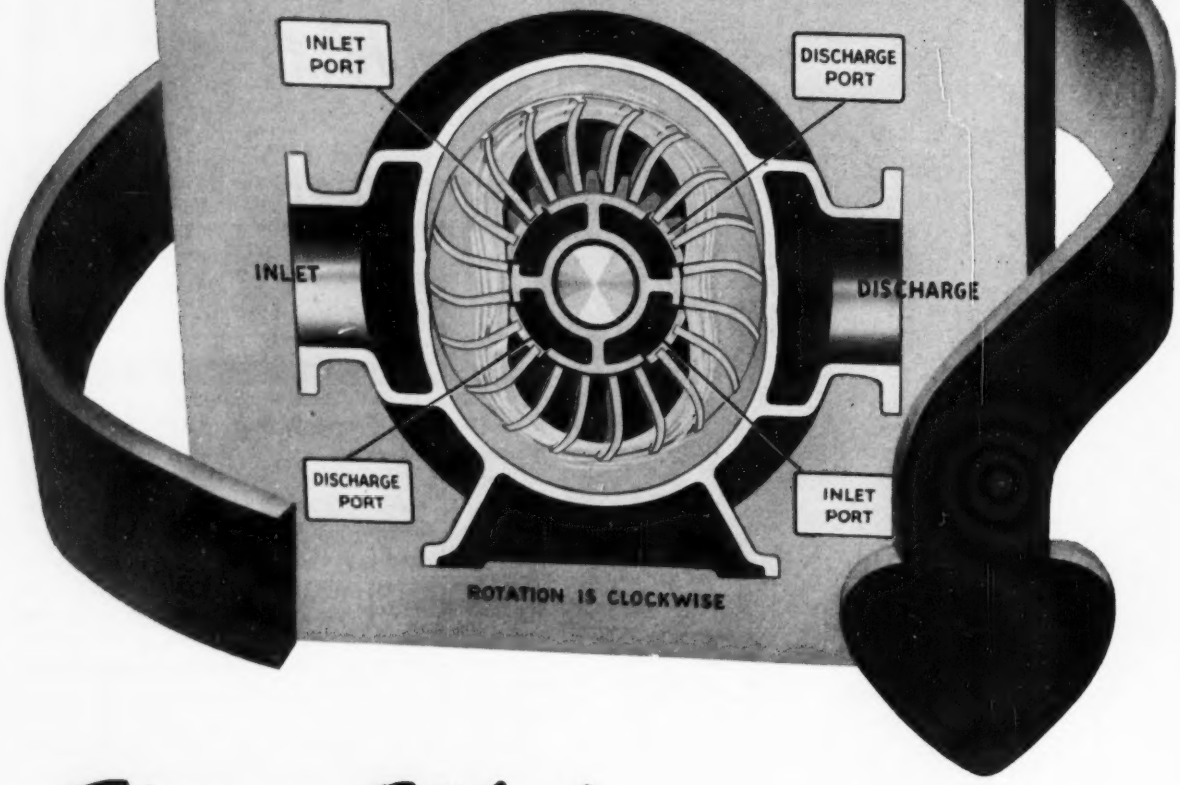
WM MILLER INSTRUMENTS, INC.

CUSTOM INSTRUMENT DESIGNERS AND MANUFACTURERS

325 N. HALSTEAD AVENUE • PASADENA 8, CALIF. • RYAN 1-6317

For more information circle **30** on inquiry card.

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters



Here is Why!

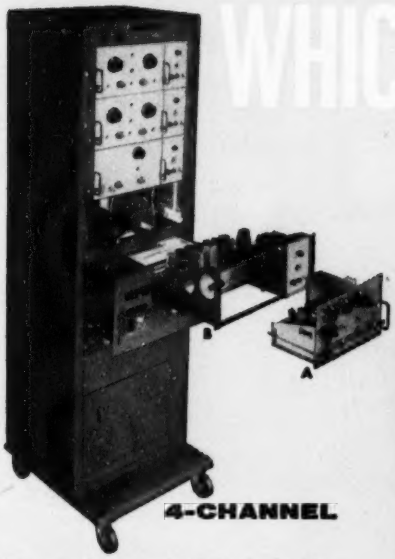
You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

- No oil filters.
- No dust filters.
- No internal lubrication to contaminate air handled.
- No internal wearing parts.
- No valves, pistons, or vanes.
- Non-pulsating pressure.
- Original performance constant over a long pump life.
- Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

WHICH "150" fits your oscillographic recording need?



4-CHANNEL

As a graphic example of the design idea that has brought new versatility to industrial recording, a Carrier Preamplifier (A) is shown above in position to plug into a Driver Amplifier in framework with Power Supply (B) which are normally already in place in the Basic Cabinet Assembly.

The identical design principles of the four-channel system are provided in the two-channel, the only difference being the number of channels.

Sanborn "150" Recording Systems that put to use the original design concept of amplifier interchangeability (illustrated at the left) start with either a four-channel or two-channel standard Basic Assembly, to which the user adds whatever selection or combination of pre-amplifiers (A) are needed for his recording problem. The standard Basic Assemblies comprise a metal Cabinet, Recorder, and a built-in Driver Amplifier and Power Supply (B) for EACH channel. Presently available Preamplifiers are: AC-DC, Carrier, DC Coupling, Servo Monitor, Log-Audio, and Low Level Chopper.

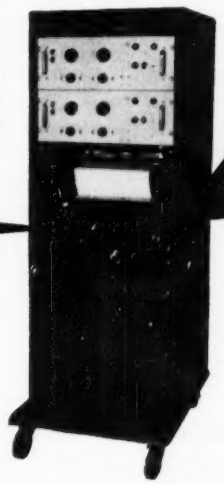
2-CHANNEL

Advantages common to ALL Sanborn Recorders are: inkless recording (by heated stylus) on plastic coated strip chart paper, and in true rectangular coordinates . . . high torque galvanometer movement . . . time and code markers . . . numerous paper travel speeds.

"150"

COMPLETE FOUR-CHANNEL SYSTEM FOR USE WITH ANALOG COMPUTERS

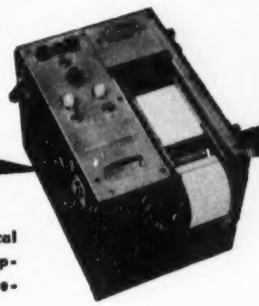
This "150" system consists of a Cabinet Assembly, a four-channel Recorder, and *two* dual channel DC Amplifiers. Each amplifier is complete with a common power supply. Each measures and records two separate single-ended signals, at sensitivities between one and one hundred volts per centimeter. The *two*-channel version of this system will comprise Cabinet, *two*-channel Recorder, and *one* dual channel amplifier.



"150"

SINGLE-CHANNEL RECORDER

A compact, lightweight unit for use when only one channel is required — provides permanent, inkless recording in *true* rectangular co-ordinates; *five* paper speeds (5, 10, 25, 50, 100 mm/sec.); *extra* stylus for either manual or remote timing and coding marks. Designed for simple, patch cord connection to *any* of the several "150" preamplifiers (plus driver amplifier and power supply), available soon in portable metal cases.



Ask, also, for a copy of the *Right Angle* — a Sanborn publication devoted to oscillographic recording in industry.

Catalog and technical data on all "150" equipment available on request.

SANBORN COMPANY

Industrial Division

CAMBRIDGE 39, MASS.

For more information circle **31** on inquiry card.

Part of the battery of 54 Leeds & Northrup Speedomax® recorders in the rocket laboratory of Bell Aircraft Corporation. They record pressures, flow rate, thrust, temperatures and turbine speed of rockets being tested in remote cells. The Bell Test Center at Modeltown has additional L&N recorders.

Atomic-energy plant operator using Speedomax Recorders

Rayotube® staring at furnace roof reports temp. to Speedomax Controller

Experimental engine test stations use Speedomax for versatility and accuracy

Medical researchers get Speedomax records in physiology

Measuring Electronic Data?

GET L&N'S **NEW DATA BOOK**

Spectacular temperatures are just one of the many conditions which L&N instruments measure, in research and in industry. Strain, flow, pressure, pH, chemical analysis—most conditions which give electric signals are being Speedomax recorded. Automatic measuring and recording is a scientific way-of-life, and L&N with its Speedomax is one of the leaders.

Speedomax instruments have been used, for example, with rockets from the Nike back to the V-2 and forward to 1954's classified missiles. L&N recorders helped initiate atomic energy utilization at the Chicago Stadium reactor, and they are helping at every other A.E.C. installation. They measured and recorded reams of data for Flying Forts, and also for today's "X" aircraft and jet engines. Speedomax equipment is in chemical research, medical research, weather forecasting, power generation, and of course in manufacturing of all kinds.

Any engineer or scientist with signals to record is invited to send for our Technical Publication "New Horizons". It brings 43 pages of performance data, circuit diagrams, charts and other engineering information. Write our nearest office, or 4955 Stenton Ave., Philadelphia 44, Pa.

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instruments — *automatic controls • furnaces*

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Editorial...

Instruments and AUTOMATION

England Awaits the Automation Show

The First International Automation Exposition will be held in the 244th Regiment Armory, New York City, November 29th to December 2nd, 1954. The Second International Automation Exposition has been scheduled in the Chicago Navy Pier, November 14-17, 1955. Thereafter the expositions will be held on an every-other-year schedule in the odd-numbered years.

The following is a reprint of the editorial in the July issue of the British Journal *The Industrial Chemist*, commenting on the forthcoming Automation Exposition. The "most widely known instrument propagandist" refers to Richard Rimbach.

Design for Control

An announcement has just been received of the "First International Automation Exposition," which is to be held in New York from November 29 to December 2 this year. As would be expected when the title comes from the pen of America's most widely known instrument propagandist, every word has been carefully chosen. The significance of "first" and "international" are obvious when it is remembered that in 1951 a report on a very successful international conference on automatic control, held in England, appeared in this journal and that the Instrument Society of America has organised an international conference to be held in Philadelphia in September. Clearly this exposition is going to be different in nature, probably in scope, and certainly in objectives. The clue to the latter is quite clearly given by the word "Exposition" and the announcement confirms that the intention is not merely to hold an exhibition, nor to discuss original papers, techniques and equipment available for "automation," which is not a word to be found in the Oxford Dictionary.

. . . . from the admirably brief explanation given by the organisers of the exposition, we gather that automation is not another word for automatic control, but that it embraces in addition the methods of making factories controllable. In other words, if we are going to "automate," if that is the correct verb, we must not think only in terms of the control equipment, but also of the design of the plant and the layout of the factory, the nature of the process and, in fact, the form of the product. This is a basic principle which this journal has stated from time to time in a modest effort to emphasise the importance of making progress towards the design of process and plant for automatic control. An "exposition" which sets out to disseminate knowledge about this principle is of considerable interest.

There is, however, another and most important feature of the exposition which makes it of particular interest and at first sight brings a measure of consolation. It is designed to educate industrial management and engineers in the possibilities of "automation". Perhaps then the admonitions of the O.E.E.C. Report and of the Anglo-American Productivity Council's Report on "Heavy Chemicals" were equally applicable to the U.S.A.? But we are left in no doubt by the implication given in smaller print; this concerns the completely automatic factory.

However, progressive organisations in this country are not unaware of the necessity of working towards the fully automatic plant for processes which would make it economic and, of course, atomic energy plants in both America and Great Britain are already virtually fully automatic. The important innovation introduced by this exposition is that it sets out, not only to exhibit the techniques and equipment available, but at the same time to give concentrated instruction in their use and value. It has been a general complaint of visitors to exhibitions everywhere that all too often there is inadequate opportunity of learning about the exhibits, and it is suggested that organisers of exhibitions of chemical plant equipment, particularly in the rapidly expanding field of instrumentation, should seriously consider following the precedent set by the organisers of the Automation Exposition.

This editorial comment shows that England is aware of the importance of The First International Automation Exposition in defining the field of automation—and that the technique of combining educational clinical class sessions with the exhibits of computers will be watched closely.

Registrants to the Computer Clinic will receive instruction on both analog and digital computers in accordance with the following suggested outlines:

Suggested Outline for Analog Computers:

A. Representation of Mathematical Relations
B. Algebraic Operations
C. Integration and Differentiation
D. Machine Variables
E. Scale Factors (Time Scale)
F. Simulating the Problem
G. Patching the Problem
H. Typical Applications
I. Computer Features
J. Question and answer period

Suggested Outline for Digital Computers:

A. Basic Functions
B. Types of input mechanisms—punch cards, tape, etc.
C. Preparation of inputs
D. Functions and capacity of central computer
E. Reading speeds, access time, etc.
F. Outputs
G. Typical Applications
H. Computer Features
I. Question and answer period

Those who wish to register for the Computer Clinic are urged to write for forms or to indicate their interest on the Reader Service Card on page 1671. Advance registration for the Automation Exposition also can be obtained by checking this card.

Pardon Us!

Gentlemen:

Our attention has been called to an article entitled "Tool and Gage Inspection", appearing at Page 1314 of *Instruments and Automation* for August, 1954. Fig. 1 of this article is captioned to indicate that the picture shows a Pratt and Whitney internal comparator.

Actually, the photograph shows a Cleveland Instrument Company "MICRO-AC" external comparator being used to inspect gage blocks. This instrument reads .000001" per division of the meter scale. A model is now available that reads .0000005" per division of the meter scale.

Yours truly,
CLEVELAND INSTRUMENT COMPANY

Let's Break This Impasse

by MILTON ARONSON

AN instrument exists which can answer the vital "what is the best way to do it" question. In so doing, this instrument can make possible the saving of large sums of money in many industrial plants. The instrument is a proved device, already in general use at the *design and development level* in aircraft, automotive, and other industries. Its price (from $1000 to $15,000 and up, depending on the magnitude of the problem) is such that its purchase could be justified by any plant with efficiency problems involving the interaction of many variables. Yet the instrument is not being used at the *operation level* where vast problems in efficiency exist—problems which the instrument can answer. What is the impasse that restrains general use of this instrument?

The instrument is the analog computer. First, let us examine the type of problems which the computer can handle:

1. With a given control system on a fractionating column, what are ranges of operation conditions under which the system performs satisfactorily?
2. With a given continuous-process control system, what are the optimum controller settings?
3. In a batch process, what are the optimum controller settings for each new set of initial conditions?
4. Can an existing unit process equipment be modified or redesigned to improve transient and steady-state response, and hence improve product quality and yield?
5. What are the performance and range requirements for a controller to control a difficult heat-transfer process unit?
6. A centrifuge has input of unknown and variable consistency. The power required to drive the centrifuge depends not only on the input consistency but also on the solids build-up within the centrifuge. What is the best way to control the centrifuge?
7. A large generator mounted on a balcony vibrates excessively. What is the best way to reduce the vibration?
8. What is the best way to control a heat-exchange unit?
9. In substituting a less-expensive solvent in a process, what happens to the control setup?
10. In moving large quantities of materials, what is the most economic setup considering pump size and cost, pipeline size and cost, and various rates of transport, changes in demand, equipment retirement rates, etc?
11. In what way will a normal spread of tolerances affect product performance and manufacturing yield?
12. In an exothermal process, what is the rate at which constituents should be added to compensate for ambient temperature changes?
13. What is the effect of time delays in process control equipment on the average quality of the product?
14. What controller settings should be used to operate a plant most economically? To operate a plant to give the highest quality of product? To give the greatest quantity of product?

This list of operational problems shows that an analog computer can find extensive use *within* an operating plant.

Which men within the plant are the men who must face and answer these problems? This is the second important question.

The answer is that the "process control" or "systems engineering" or "efficiency" department in the modern plant is the Instrument Department. It is this department which today has the responsibility for operation and maintenance of the existing control equipment. It is this department which has the facilities and know-how to operate and maintain complex electronic, pneumatic, hydraulic, and mechanical control equipment. It is this department which could make most effective and economic use of the analog computer. The Instrument Department of a modern large process industry is in position to break through the roadblock.

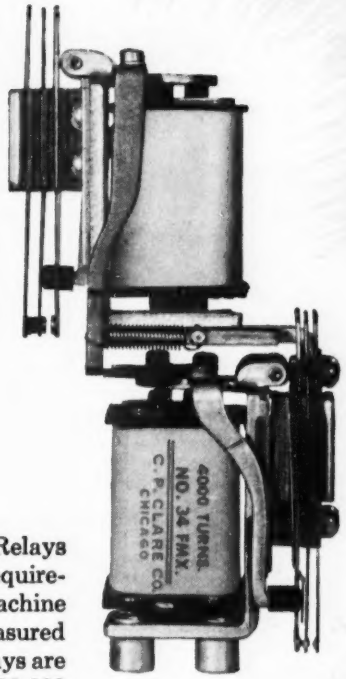
Then why doesn't the Instrument Department now use the analog computer? The impasse is this: It is the limited knowledge of process functions that prevents greater immediate application of the analog computer within the plant; and it is limited knowledge of simulation techniques that limits the knowledge of the process functions.

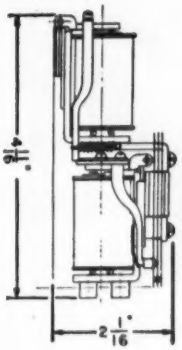
The Instrument Department holds the key to this situation. By instituting a program of simulation, the Instrument Department could determine (1) the electric analogs and parameters of unit process operations, (2) the electric analog and parameters for all closed-loop control systems within the plant, (3) optimum methods for control of the operations within the plant, (4) the answers to all problems similar to the 14 mentioned previously—which problems occur periodically.

An important byproduct would be the feedback of operational data from the user to the designer. Today the designer must use only theoretical and approximate data on which to base his simulation of a unit process. Needless to say, the theoretical and operational characteristics of most unit operations are not the same. Hence the designer, who knows the power of simulation methods, is handicapped by lack of performance data. The Instrument Department, which has (or could obtain) the operational data, is handicapped by lack of simulation experience.

The Instrument Department holds the key. It knows what data are required and is best equipped to obtain them. We predict that the progressive Instrument Department soon will have its own simulation section in which full-time personnel will simulate all operations within the plant, using performance charts to obtain the equations and parameters, and using the analog computer to seek optimal methods and techniques for the control of all operations within the plant. The Instrument Department will then become not only the control center of the plant, but also the communication and data center whose job will be to provide management with all the information necessary to realize the plant objectives.

New CLARE Type LG Relay increases life expectancy of electromechanical latching relays to millions of operations





TYPICAL CIRCUIT FUNCTIONS

1. **Hold contacts operated any length of time without consuming power.**
2. **Operate contacts over one lead; release them over another.**
3. **Act as overload relay—electrically reset from remote point when tripped.**
4. **Act as interlocking relay pair on either a-c or d-c—or on combination of both.**

CLARE Type LG Electromechanical Latching Relays were designed to meet the punishing service requirements of an internationally known business machine manufacturer. Where other such relays measured their life cycles in thousands, Type LG a-c relays are still operating satisfactorily at well over 15,000,000 operations.

The assembly shown consists of two CLARE Type GAC a-c relays with interlocking armatures. They are aligned one above the other on a common mounting bracket to save chassis space. The assembly may also consist of two Type G d-c relays, or one a-c and one d-c relay.

Relay operation is as follows:

1. When either relay is energized while the other, deenergized, relay is latched up, it will unlatch the other relay, allowing it to restore, and will latch itself up.
2. When either relay is energized while the other is already energized, it will operate its own contacts without latching up, and without affecting the other relay. It will release as soon as its coil circuit is opened. The two relays, however, can be interlocked electrically so that both coils cannot be energized at once.
3. When either relay is deenergized while the other relay is energized, the other relay will become latched up.

For full information on this new relay or for consultation on any relay problem, we invite you to contact your nearest CLARE sales engineer or write to C. P. Clare & Co., 3101 West Pratt Blvd., Chicago 45, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13, Ontario. Cable Address: CLARELAY.

Write for Bulletin 118

CLARE RELAYS

FIRST IN THE INDUSTRIAL FIELD

Specifications

MECHANICAL:

COILS:
D-c, single-wound, up to 25,000 ohms; double-wound—(concentric only) to 5000 ohms each winding.

MAGNETIC CIRCUIT:
Armature and heel piece of low-loss iron provide efficiency comparable to that of Type G or Type GAC relay. Cores of a-c coils are of laminated silicon steel. Copper shading rings fitted to pole faces to prevent armature chatter.

ARMATURES:
Single-arm. A-c relays have precision-reamed, heavy-duty armature bearings and stainless steel bearing pins.

RESIDUALS:
Fixed (plate) or adjustable (lock screw) on d-c relays.

ARMATURE LATCH:
Arm projects downward from armature of upper relay and engages latch projecting outward from armature of lower relay. Step on lower latch prevents overthrow. Retractile spring helps restore upper armature when latch is disengaged. Latching members specially treated by most modern metallurgical methods for maximum wear resistance.

CONTACTS:
Forms A to E available. Maximum of 6 springs per relay.

WEIGHT:
Net (approx.) 1 lb. Shipping—2 lbs.

ELECTRICAL:

COIL VOLTAGE:
(Maximum) a-c, 220 volts, 20 to 120 cycles; d-c, 220 volts.

COIL RESISTANCE:
A-c, wound to number of turns specified, plus or minus 5%; d-c, resistance as specified, plus or minus 5%

COIL DISSIPATION:
(Maximum) For continuous duty: a-c, 10 va; d-c, 6 watts.

AMPERE TURNS REQUIRED:
(d-c relay) with two Form C contacts, 500.

HIPOT TEST:
Standard, 1000 volts rms.

For more information circle 33 on inquiry card.

Lectrodryers
TRAP HARMFUL MOISTURE BEFORE IT REACHES AIR LINES

DRY air protects against freeze-ups and prevents harmful moisture from causing sludge or rust that may clog delicate instrument orifices. DRY air insures a clean, free flow to finely balanced controllers, valves and instruments . . . actually reducing maintenance problems.

Prevent harmful moisture condensation in air lines and obtain a flow of clean, DRY air by installing a Lectrodryer* and a Lectrofilter* at your air compressor. The filter frees the air of oil and grime after it leaves the compressor. The Lectrodryer continuously and automatically DRYs the air to dewpoints as low as – 100°F, depending on your need.

Investigate the new "BY" Lectrodryers. They're designed especially for instrument air service. They contain no moving parts, assuring minimum maintenance. And their DRYing adsorbent, Activated Aluminas, will not wear out.

Write for the booklet *Because Moisture Isn't Pink.* It describes Lectrodryers and how industries are using them. We will welcome any inquiry you might have regarding DRYness engineering. Pittsburgh Lectrodryer Corporation, 330 32nd St., Pittsburgh 30, Pennsylvania.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

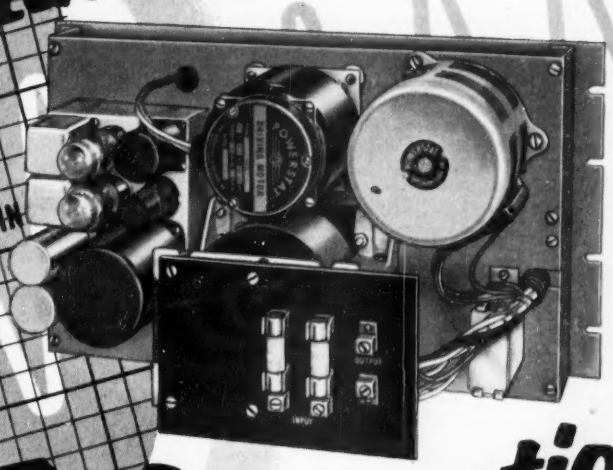
LECTRODRYER

*REGISTERED TRADEMARK U.S. PAT. OFF.

For more information circle **34** on inquiry card.

Maintain Constant Output Voltage

THE WAVE THAT GOES IN



COMES OUT UNCHANGED

STABILINE
Type EM4102R

with Zero Waveform Distortion

If you want to maintain constant output voltage with zero waveform distortion or constant voltage to large industrial loads, you will find the STABILINE Type EM the answer.

STABILINE automatic voltage regulators Type EM not only stabilize and regulate the voltage output and exactly reproduce the input waveform, but feature:

- **outstanding efficiency — comparable to the most conservatively designed fixed-ratio transformers**
- **fast correction rates for voltage changes**
- **wide input voltage ranges**
- **adjustable output voltage settings**
- **adjustable operating sensitivity**

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THE
SUPERIOR ELECTRIC
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Manufacturers of: Powerstat Variable Transformers • Stabiline Automatic Voltage Regulators • Voltbox A-C Power Supplies • Powerstat Light Dimming Equipment • Varicell D-C Power Supplies • Superior 5-Way Binding Posts

Send coupon below for full details.

THE SUPERIOR ELECTRIC COMPANY
710 Clarke Ave., Bristol, Conn.

Please send Bulletin S351 on STABILINE automatic voltage regulators.

Name.....

Position.....

Company Name.....

Company Address.....

City.....Zone.....State.....

For more information circle **35** on inquiry card.

The Month's NEW INSTRUMENTS

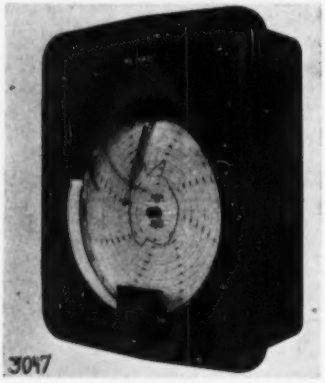
In this department we report each month new devices for measurement, inspection, testing, computing, metering and automatic control—in the form of concise technical descriptions.

FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 1671

PROCESS CONTROL

Telemetering System

New "Teletax" impulse-duration telemetering system for flow-rate, process flow, pressure, liquid level, temperature and other variables can handle distances up to 150 miles by

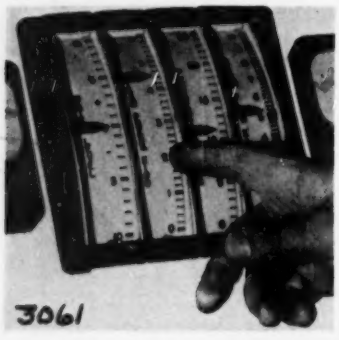


wire; can be operated over radio link or microwave channels. Signal level can vary widely without affecting operation or accuracy. At 12-second intervals, transmitter sends a pulse to receiver proportional in duration to variable being measured. Receiver automatically compares pulse duration and actuates a reversible motor which positions recorder pen or indicator pointer. System uses relatively few moving parts, each easily accessible and serviced without special tools.—*The Foxboro Co., Foxboro, Mass.*

For more information circle **201** on inquiry card.

Remote Indicators

New miniature remote indicators with 5-inch usable scale are easy to read. Among features: removable units; easy "one-man" zero adjustment; no parallax; internal illumination; and flush or semi-flush panel mountings. Each indicator can be supplied as an electric or pneumatic



receiver for pressure, draft, flow, level or temperature. Pneumatic type uses a spring-loaded metallic bellows with built-in overpressure protection, or a Bourdon tube. Electric model uses a specially-designed motor, electronic amplifier, and a pair of differential transformers (one at transmitter, the other at indicator) forming an electric null balance circuit.—*The Hays Corp., Michigan City, Ind.*

For more information circle **202** on inquiry card.

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Telemetering System

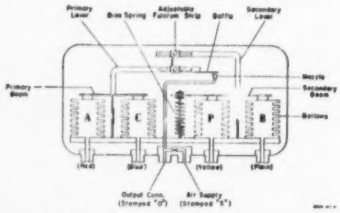
New "Varec" pulse code telemetering system utilizes a prearranged code for each increment of intelligence to be transmitted. Transmitter sets up and transmits code for particular value of liquid level, or other informa-

tion. At receiver, code is translated into equivalent measurement increment. There are no borderline cases where value may fall between two increments. Reliability is enhanced by utilizing some features found in other systems. For example, "pulse counting" is added to "pulse code" system receiver so that unless correct numbers of pulses are received, no reading will be displayed. Receivers are available in steel cases for flush panel mounting, or in steel cabinets for desk-top use. Transmitters are available in three general types: for use with the gages using ½-in. steel tapes; for high-pressure service using magnetic coupling through metal partition; for low-pressure service (to 30 psi.).—*The Vapor Recovery Systems Co., 2820 No. Alameda St., Compton, Calif.*

For more information circle **203** on inquiry card.

Process-control Computer

New "Transet Computing Relay" is a pneumatic force balance transmitter for applications where close computing accuracy is required; is



capable of adding, subtracting, averaging and ratioing; handles up to three separate pneumatic input pressures with accuracy of 0.5 percent (hitherto unattainable in industrial instrumentation). New instrument is especially useful in any process where two or three different signals must be compared and where variables are required to maintain a constant relationship to one another. It comprises four receiver bellows, a fixed nozzle, a movable baffle, and a system of fixed and adjustable levers. Output is linear to input pressure.—*Taylor Instrument Companies, 95 Ames St., Rochester 1, N. Y.*

For more information circle **204** on inquiry card.

Proportioning Pump

New "Hills-McCannameter" is a proportioning pump with no packing, unique high-speed valves and pulse-free flow; is described by maker as "the meter that pumps." Wide output flow range adjustable by finger pressure while pump is operating or stationary: from 5 c.c. to 6 gal. per hour per feed, depending somewhat on material being handled. Standard speeds 27 to 900 strokes per minute. At higher speeds and higher capacities particularly, flow is continuous for all practical purposes. Gases and vapors are vented automatically. Standard units will develop pressures up to 2,500 psig. Regulation is adaptable to automatic control. All feeds can be

For more information circle **36** on inquiry card.→

ARGON PURITY

THE ARGON STORY

One of the greatest obstacles to the use of Argon gas for welding purposes has been overcome by Thermco. Manufacturers previously have encountered difficulty in the manufacture of the gas because of certain impurities present. Obtaining the desired degree of purity was difficult due to the fact that suitable instruments for measuring argon purity were not commercially available.

The first commercial argon purity analyzers were manufactured by Thermco at the request of the Independent Engineering Company of O'Fallon, Illinois, who are engaged in designing equipment for the producton of Argon gas. The six analyzers that were delivered to various producers were the first ever to be used on a commercial basis, since prior analyzers were only designed for laboratory use.

Thermco's ARGON PURITY ANALYZERS operate by comparing the thermal conductivity of the sample gas with a reference gas. This simple method combined with Thermco's unique ability enables purity to be determined to closer than one hundredth of one percent under plant conditions.

PLANT CONTROL

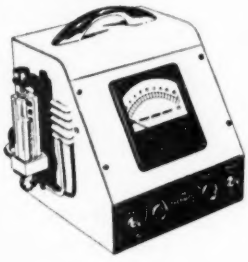
A troublesome problem of present day plant control is the margin of error when assuming that compositon is correct when the physical conditions are held constant. To assure a better end product: control by actual chemical composition is the answer. Thermco Laboratories have illustrated that the thermal conductivity method is a practical solution for many problems. The simplicity of this method means that it is easily adapted to plant control.

If you have a problem in plant control, Thermco's vast knowledge is at your service. Their special know-how in applying this method may be the answer to your problem. Thermco welcomes inquiries and will develop new methods and modifications to meet your particular needs.

Complete instrumentation is available, including the mounting panels fully piped and wired in our shops. Expert service can be provided for start-up.

RECORDING GAS ANALYZERS

Purity of Argon - Carbon Dioxide - Helium and Hydrogen - Traces of Moisture - Oxygen and Hydrogen - Safety for Explosive Limit - Hydrocarbon Vapor - Instrument Panel Process Control.



PORTABLE GAS ANALYZERS

Flue Gas - Gas Air Ratio - Atmosphere - Sulphur Dioxide - and numerous other Gas Mixing Applications.

INDICATING GAS ANALYZERS

Purity of Argon - Carbon Dioxide - Helium and Hydrogen - Gas Mixing - Atmosphere Measurement - Safety Alarm - Explosive Limit - Chemical Hood Control - Atmosphere Control.

THERMCO
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Circle 36 on inquiry card.

Meet the Widest Range of flow measurement requirements with

AMERICAN-WESTCOTT A-88 ORIFICE METERS

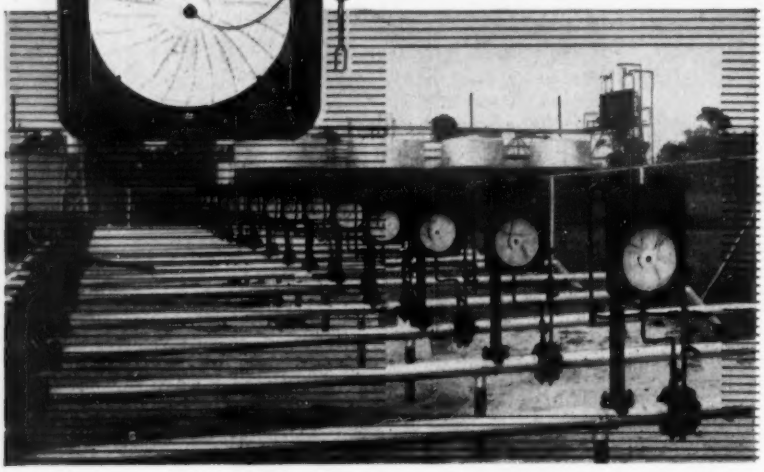
RECORDING • INDICATING
INTEGRATING • TELEMETERING

American A-88 standard mercury type orifice meters for working pressures to 5000 psi. in interchangeable 10, 20, 50, 100 and 200-inch ranges give you complete versatility to meet any flow measurement requirement. Integrating instruments integrate both static and differential pressures giving totalized flow indications and telemetering equipped instruments transmit integrated indications to remote locations.

Recording Meters may be equipped with standard O-150°F. Temperature Elements, as illustrated, giving you every advantage of better temperature measurement with speed, accuracy, simple installation, economy and freedom from maintenance.

Wherever accurate recording and precision measurement are wanted...at high or low flow rates ... at varying temperatures ... there's a job for American® Series A-88 Orifice Meters.

Write for full details now.



AMERICAN-WESTCOTT MERCURY MANOMETERS GIVE YOU ALL THESE ADVANCED DESIGN FEATURES . . . . . .

- Minimum Simple Maintenance—easy access to float lever arm during calibration.
- Highest Accuracy—inherent straight line calibration.
- Interchangeable Ranges—no manifold piping changes.
- Pressure-Tight Teflon-Packed Stuffing Box—nearly frictionless, free from maintenance troubles, never needs lubrication.
- Teflon-Packed Pulsation Dampener—externally adjustable under full line pressure without leakage.
- Dependable Performance—improved check valves give positive shut-off for over-range protection.

AMERICAN METER COMPANY

GENERAL SALES OFFICE: 1513 Race Street, Philadelphia
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Omaha • Pittsburgh • San Francisco • Seattle • Tulsa
IN CANADA: Canadian Meter Company, Limited, Hamilton
Edmonton • Calgary

For more information circle **37** on inquiry card.

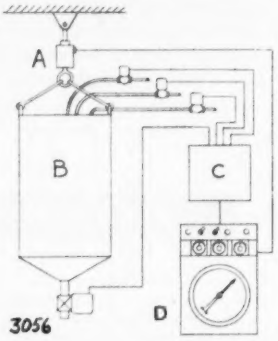
NEW INSTRUMENTS

adjusted simultaneously and identically. It is also possible to provide for inverse proportioning between feeds.—*Hills-McCanna Co.*, 3025 *North Western Ave., Chicago* 18, *Ill.*

For more information circle **205** on inquiry card.

WEIGHING

New "Model 140 Auto-Batch" weighing equipment, for program batching of liquids and bulk material, features SR-4 load cell or cells *A* supporting tank or bin *B*, electronic indicator recording controller *D*, to convert load signal into proper functions, and control relay box *C* to sequence functions in proper order and duration. Systems are available to handle materials batching from a few pounds to thousands of pounds. One to twelve different ingredients can be handled with no more effort than dialing loads required.—*Gilmore Industries*, 5713 *Euclid Ave., Cleveland* 3, *Ohio.*



For more information circle **206** on inquiry card.

Filling Machine

New "Filamatic Universal Weighing and Filling Machine" automatically net-weighs and dispenses into containers any non-liquid product that will pass through a hopper. There being no stirrers, agitators, or mechanical cut-off, there can be no crushing or damage to articles being dispensed. A vibrating type feeder insures accurate dispensing, even with hygroscopic and fatty non-free flowing powders. A dustproof casing protects the operator from dust. Available models cover range from 0.003 oz. to 5½ lbs. per fill.—*National Instrument Co.*, 5005 *Queensbury Ave., Baltimore* 15, *Md.*

For more information circle **207** on inquiry card.

Automatic Net Weigher

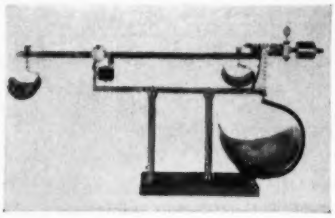
New automatic net weighing machine has load discharge timer and counter for all types of free-flowing materials; is fed by a vibratory feeder until predetermined amount is in

weigh bucket. Bucket will not discharge its contents, however, until pre-set time interval has elapsed. Counter unit records number of weighments; shuts off operation at pre-set number of loads. Pushbutton panel permits manual control when desired. Unit capacities available from a few ounces to 25 lbs. with dial and beam calibrations in either Metric or Avoirdupois.—*Exact Weight Scale Co., 944 W. Fifth Ave., Columbus 8, Ohio.*

For more information circle **208** on inquiry card.

Counting Scale

New "Micro Counter Model No. MC-22" replaces "Model No. MC-2," has a total capacity of 4 lbs.; will count pieces as light as 5/1000ths of

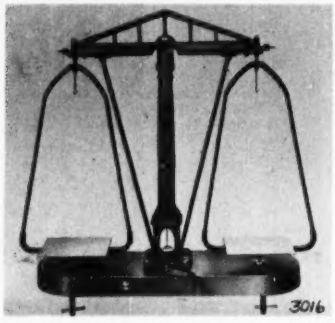


an ounce in ratios of 10 to 1 or 100 to 1. Single beam, instead of double beam used earlier, increases sensitivity and durability. Longer balance pointer for easier reading; reinforced damper bar for increased rigidity.—*John Chatillon & Sons, 85-93 Cliff St., New York 38, N. Y.*

For more information circle **209** on inquiry card.

Large-capacity Balances

Two large-capacity balances, "Model BB-3 and BB-4," have capacities of 15 and 30 kg., sensitivities of 33 and 66 mg. Bronze beam sustains full load without flexure and keeps adjustment



through temperature changes. During arrestment, loading and unloading, knife edges are relieved from bearings and protected against wear and injury by beam arrest. Indicator oscillates inside column over a horizontal scale to prevent accidental damage.—*Torsion Balance Co., Clifton, N. J.*

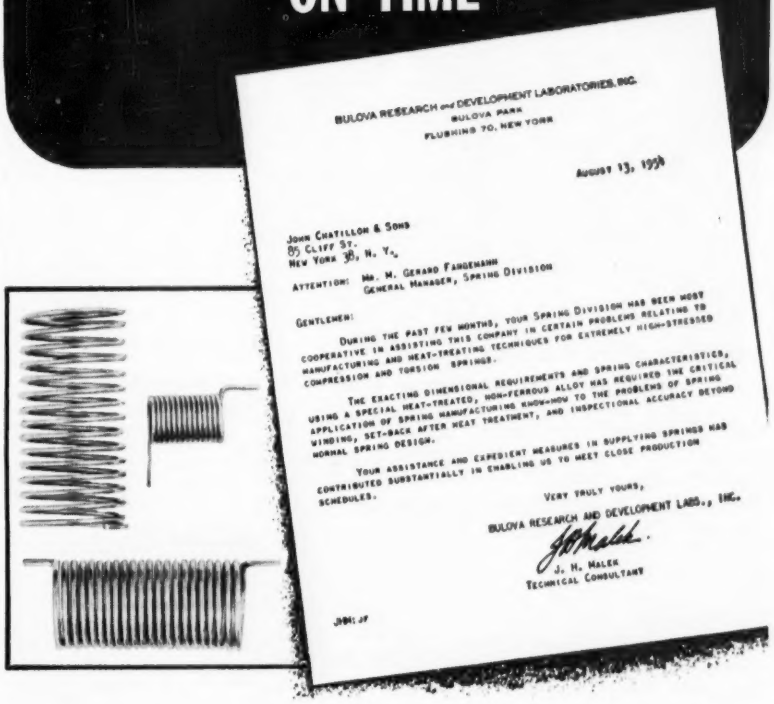
For more information circle **210** on inquiry card.

FLOW and VOLUME

Quadrant Orifice Plate

New quadrant orifice plate utilizes result of research in the development of an orifice type element designed to measure flows of liquids under varying viscosity conditions. Rounded approach on upstream face makes

CHATILLON
SPRING DESIGN KNOW-HOW
KEEPS BULOVA PRODUCTION "ON TIME"



BULOVA RESEARCH and DEVELOPMENT LABORATORIES, INC.
BULOVA PARK
FLUSHING 70, NEW YORK

August 13, 1953

JOHN CHATILLON & SONS
85 CLIFF ST.
NEW YORK 38, N. Y.

ATTENTION: MR. H. GERARD FARGEMANN
GENERAL MANAGER, SPRING DIVISION

GENTLEMEN:

DURING THE PAST FEW MONTHS, YOUR SPRING DIVISION HAS BEEN MOST COOPERATIVE IN ASSISTING THIS COMPANY IN CERTAIN PROBLEMS RELATING TO MANUFACTURING AND HEAT-TREATING TECHNIQUES FOR EXTREMELY HIGH-STRESSED COMPRESSION AND TORSION SPRINGS.

THE EXACTING DIMENSIONAL REQUIREMENTS AND SPRING CHARACTERISTICS, USING A SPECIAL HEAT-TREATED, NON-FERROUS ALLOY HAS REQUIRED THE CRITICAL APPLICATION OF SPRING MANUFACTURING KNOW-HOW TO THE PROBLEMS OF SPRING WINDING, SET-BACK AFTER HEAT TREATMENT, AND INSPECTIONAL ACCURACY BEYOND NORMAL SPRING DESIGN.

YOUR ASSISTANCE AND EXPEDIENT MEASURES IN SUPPLYING SPRINGS HAS CONTRIBUTED SUBSTANTIALLY IN ENABLING US TO MEET CLOSE PRODUCTION SCHEDULES.

VERY TRULY YOURS,

BULOVA RESEARCH AND DEVELOPMENT LABS., INC.

J. H. MALEK
TECHNICAL CONSULTANT

JHM: JF

Production men at the Bulova Research and Development Laboratories were unusually hard-pressed to find the most suitable techniques for manufacturing extremely high stressed, heat-treated compression and torsion springs. Chatillon engineers familiar with every type of precision spring manufacturing problem were called in and provided the answers promptly. Bulova's production program proceeds as planned!

Chatillon specializes in the manufacture of all types of precision springs, making use of all spring alloys. Our temperature-compensated alloy called "Iso-Elastic"*—a noteworthy Chatillon development—is used extensively in the instrument field where constancy of spring characteristics is imperative with changes of temperature.

Your instruments can be improved too! Contact Chatillon Spring Division for assistance, or write for engineering bulletins on Iso-Elastic springs.

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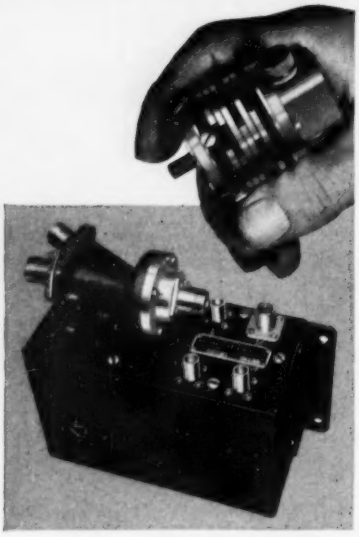
85 CLIFF STREET, NEW YORK, N. Y.
Manufacturer of Precision Springs and Measuring Apparatus Since 1835

For more information circle **38** on inquiry card.

BARBER COLMAN

permanent-magnet d-c motors



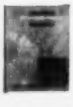
chosen to drive National Instrument Co.'s coaxial lobe switches

As a component of submarine detection equipment on aircraft, the Coaxial Lobe Switch produced by National Instrument Co., New York City, must operate at high speed under carrier conditions at sea and environmental extremes. It is driven by a Barber-Colman type BYLM d-c motor as shown above. Since changing to this motor the manufacturer reports, "The motor is very steady, has no tendency to vary in speed at constant load, does not overheat." If you have a design problem calling for improved performance of switches, actuators and programming devices, investigate this compact new permanent-magnet d-c motor.

IN TWO FRAME SIZES WITH MAXIMUM OUTPUTS OF 30 mhp and 56 mhp

- Superior Commutation
- Withstand Sudden Reversals
- Powerful Dynamic Braking
- Meet Military Specifications
- Low Radio Noise Interference

Write for descriptive Bulletin F-4344 showing wide range of adaptations available to you with BYLM series Barber-Colman permanent-magnet motors. Bulletin includes characteristic curves, specifications, and application information. Get your copy now.



BARBER-COLMAN COMPANY

Dept. J, 1415 Rock Street, Rockford, Illinois

For more information circle **39** on inquiry card.

NEW INSTRUMENTS

orifice insensitive to viscosity changes so long as throat Reynolds Number does not exceed 250,000. It has, for all practical purposes, a constant coefficient over Reynolds Number range of 500 to 250,000. It is recommended primarily for fluids whose viscosities vary; also lends itself nicely to measurement of small flows.—*Taylor Instrument Companies, 95 Ames St., Rochester 1, N. Y.*

For more information circle **211** on inquiry card.

Vial Fillers

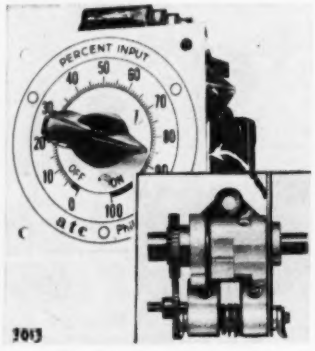
New models of maker's "Filamatic Aseptic Vial Fillers" are available with stainless steel filling units equipped with adjustable Teflon piston rings. "Wiping action" of Teflon rings prevents accumulation of solids on cylinder walls and enables filling unit to handle any free-flowing liquid including oils, suspensions and saturated solution. New units can be used with all existing models of "Filamatic." They are available in two types, one with capacity of 1cc. to 15cc. per stroke; the other from 10cc. to 15cc. per stroke. Delivery volume is varied by a micrometer adjustment.—*National Instrument Co., 5005 Queensbury Ave., Baltimore 15, Md.*

For more information circle **212** on inquiry card.

TEMPERATURE

Temperature-control Interrupters

New improvements prolong service-life and simplify operation of maker's interrupters. Nylon timing cams and contact arms reduce wear, noise, and



friction. Synchronous motor has oiled-for-life rotor. Selector knob spring is stressed against dial cam to absorb vibration. Larger contacts permit heating loads up to 4.6 kw. without external contactors.—*Automatic Temperature Control Co., Inc., 5200 Pulaski Ave., Philadelphia 44, Pa.*

For more information circle **213** on inquiry card.

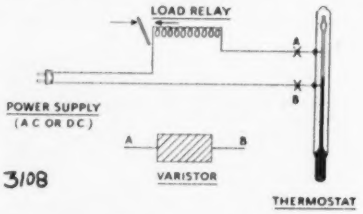
TC Extension Wires

Three new types of extension wire: 14-gage with asbestos or waterproof insulation; 14-gage Chromel-Alumel with asbestos or waterproof insulation, and 20-gage Chromel-Alumel with waterproof insulation. (14-gage types, used with I-C couples, were withdrawn from production in 1951 to conserve critical materials: Korean war.) Same thermoplastic insulation for 20-gage as for larger-gage wire. Each conductor is coated with 1/64-in. polyvinyl chloride; both conductors are covered with cotton braid impregnated with an asphaltic-base weatherproof saturant. Yellow designates positive conductor; red negative; yellow over-all color.—*Industrial Div., Minneapolis-Honeywell, Philadelphia 44, Pa.*

For more information circle **214** on inquiry card.

Thermostat Protector

New "Stat-Varistor" prevents arcing (main cause of contact failure in mercury-in-glass thermostats) by cutting down voltage surges to negligible proportions. Device is 1 in. long

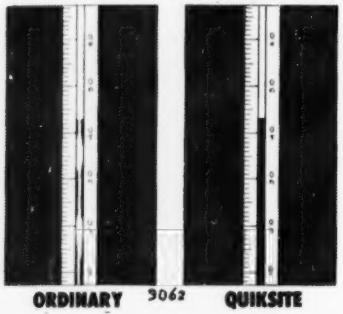


by ½ in. diam., constructed of a series of selenium plates sealed in glass. It eliminates destructive arcing by changing resistance as voltage across it is changed. It is available as a separate unit for use on existing installations or for building into new relays. Maker's own thermostats can be provided with it.—*Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia 30, Pa.*

For more information circle **215** on inquiry card.

Black-reading Mercury Thermometers

New "Quiksite" thermometers display a jet-black thread against a white



background, nullifying exterior reflections.—*H-B Instrument Co., American & Bristol Sts., Philadelphia 40, Pa.*

For more information circle **216** on inquiry card.

Temperature Controller for Diesel-electric Locomotives

New controller for diesel-electric locomotive cooling systems is for use with clutch-driven fans; will operate in temperatures from –40 to 120 F.; is unaffected by sleet storms, freezing rain, drifting snow, sand, cinders, or brakeshoe dust; will operate at altitudes over 10,000 feet as well as in tunnels.—*Locomotive and Car Equipment Dep't, General Electric Co., Schenectady 5, N. Y.*

For more information circle **217** on inquiry card.

Cold-junction Thermostat

New thermostat keeps thermocouple cold junction at a constant temperature which is accurately known. Instrument is contained in a steel case, 12 x 8 x 7½ in. An electrically-heated graphite oven has 5 cavities, 5 in. deep and 0.343 in. I.D. Each cavity can take several couples. Automatic temperature controller is mounted in same case. Instrument is factory-adjusted for 150 F. Accuracy 0.2 F.—*Weiller Instruments Corp., 2 Stone St., New York 4, N. Y.*

For more information circle **218** on inquiry card.

PRESSURE and VACUUM

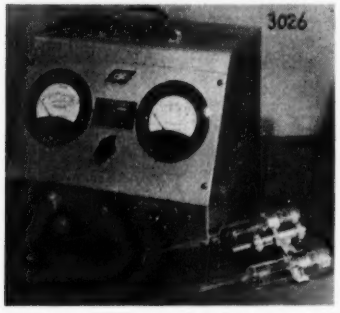
Dynamic Pressure Pickups

New "Dyna-Gage" line of maker's capacitive type pressure pickups features improved performance, including capability of operation at temperatures to 6000 F., in highly corrosive atmospheres, etc. Pressure ranges from 1 psi. to 75,000 psi.; outputs up to 15 volts with a 25,000-ohm load; frequency response from 0 to 10,000 cps.; flush diaphragm construction; high stability with water cooling; insensitivity to cable vibrations and to shock; stainless steel construction and glass-to-metal seals.—*Photocon Research Products, 421 No. Foothill Blvd., Pasadena 8, Calif.*

For more information circle **219** on inquiry card.

Pirani Gage

New "Type PG" is available in one- or two-station units with matched pair of tubes for each station supplied in either a lab-type mounting (illus-



trated) or a production-type case. Tubes uninjured when operated at atmospheric pressure. Range 0-750 microns Hg. in two scales: "millimeter" (25 to 750 microns) and "micron" (1 to 20).—*Consolidated Vacuum Corp., Rochester 3, N. Y.*

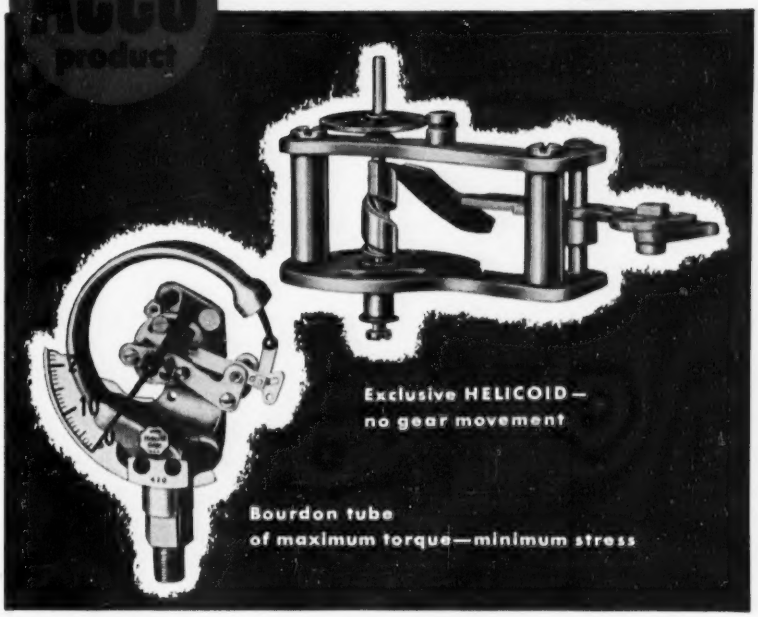
For more information circle **220** on inquiry card.

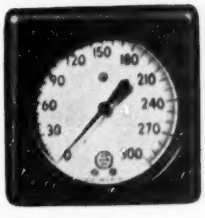
Philips Gage

New "Type PHG-09" cold-cathode ionization-type vacuum gage indicates from 500 microns to 0.1 micron on four direct-reading scales; can be operated at atmospheric pressure without damage to tube or indicator. Other

an ACCO product

Helicoid Gages





Why HELICOID Costs Less Per Gage, Per Year

HELICOID Gages have many unique and exclusive features which result in enduring accuracy and savings in maintenance cost. They cost less per gage, per year.

Only HELICOID Gages, for instance, have the Helicoid Movement . . . a simple cam and roller design which has no gear teeth to wear out. Bourdon tubes used in HELICOID Gages are carefully designed to give maximum torque and minimum stress . . . promoting the greatest possible endurance life. They withstand many millions of pressure pulsations without stretching, leaking or cracking.

There is a HELICOID long-life gage to meet every type of pressure control requirement. Pressure ranges to 20,000 psi, vacuum or compound. Dial sizes: 3½", 4½", 6", or 8½". Dials may be black, white or radiant faces. They are supplied for wall or stem mounting, flush or panel mounting, or flangeless.

All HELICOID Gages are fully guaranteed. They are time-tested and proved in years of hard service. They assure the highest degree of gage accuracy and long-life service.

Write TODAY for the G-2 HELICOID Gage Catalog

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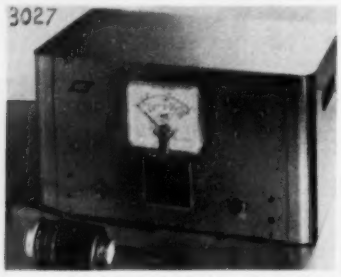
Pressure · Vacuum · Compound

For more information circle **40** on inquiry card.



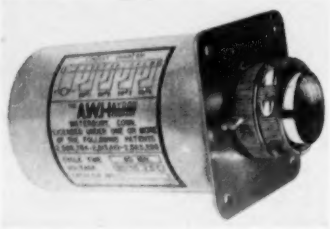
types available: with adjustable alarm circuit; one-to-six station unit panel- or cabinet-mounted.—*Consolidated Vacuum Corp., Rochester 3, N. Y.*

For more information circle **221** on inquiry card.

TIME and SEQUENCE

Repeat Cycle Timers

New hermetically-sealed miniaturized repeat cycle timers, in 2½-in. diam. aluminum housing, can be supplied with 50-, 60-, or 400-cps. motors or standard or governed d-c. motors. Radio interference filtering to meet

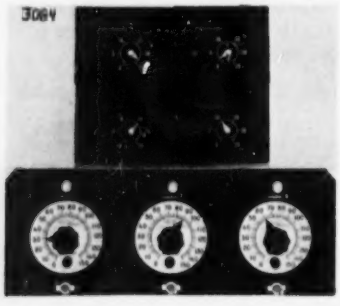


MIL-I-6181 is available for d-c. units. All are suited for local and remote control applications or continuous duty under all environmental conditions. Intercam reduction can be provided to allow high-speed pulsing with an extended cycle time. Ratchet drive in d-c. units prevents damage in case of reversed polarity. Flange mounting as shown, or three stud mounting. Also, AN connector as shown, or glass-metal header.—*A. W. Haydon Co.*, 230 *North Elm Street, Waterbury, Conn.*

For more information circle **222** on inquiry card.

Program Controller

New "Model 123" supplies current successively to different circuits, automatically, for preset periods. An indicator light always shows which circuit is being fed. Any number of circuits may be connected, and time interval on each circuit may be changed during operation by adjusting pointer setting. Any timer may be skipped

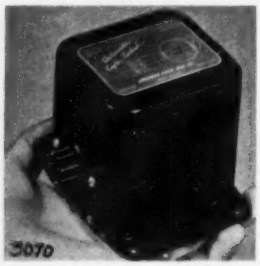


without changing its dial setting by switching it out of system. Main switch contacts in each timer have s-p.d-t. arrangement, so each timer can easily be wired to control two circuits. Contacts are UL rated 20 amps. at 125 v.ac.—*Masco Products Co.*, 2119 *So. Sepulveda Blvd., Los Angeles* 25, *Calif.*

For more information circle **223** on inquiry card.

Automatic Timer and Cycle Control

New automatic control "brain" will control any electrical machine operating through a cycle: (1) for timed quantity measurements in production processing of liquids or solids; (2) for coin-operated vending machines; and



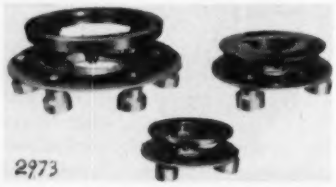
(3) for sequential production operation. It prevents delivery of articles or materials as long as a normally pulsed circuit is closed continuously. Cycle of operation may be 2 seconds or 2 weeks. In event of any interruption, normal cycle is completed and machine shuts off to prevent loss of material or revenue. After interruption is cleared, device automatically resets cycle for normal operation.—*Johnson Fare Box Co.*, 4619 *N. Ravenswood Ave., Chicago* 40, *Ill.*

For more information circle **224** on inquiry card.

SPEED

Centrifugal Switches

New larger capacity "Syncro-Snap" centrifugal switches, suitable for use on units rated as high as 5 hp., are available in 3 models; can be furnished



in a size and shape to fit a wide range of applications at almost any normally required throw-out speed. Originally designed as a non-fluttering instant-action switch for single-phase motors, it is also suitable for use as a compressor unloader, gasoline engine speed control, limit and sequence control for over and under-speeds, etc. Feature is requiring a rapidly-decreasing rate of pressure at critical switching point. This feature, combined with rapidly-increasing centrifugal pressure (square of shaft speed) results in positive snap action, eliminating tendency to "flutter" or "chatter."—*Torq Engineered Products, Inc., Interstate St., Bedford, Ohio.*

For more information circle **225** on inquiry card.

Tachometric Governors

New governor contains two snap-action switches rated at 10 amps. 110 v. a.c.; can be used for opening or closing circuits at any speed setting over 350 rpm. Each switch is individually adjustable up to 2000 rpm. above specified set speed. On redesigned governors, knurled adjusting ring has been eliminated and replaced with three set screws in angle slots, making possible an adjustment range of 20 percent increase or decrease. Two body designs: "GS" adaptable to standard distributor take-off and has oilless bronze bushings; "GH" for standard SAE tachometer drive and runs in oil-sealed ball bearings.—*Synchro-Start Products, Inc., Skokie, Illinois.*

For more information circle **226** on inquiry card.

COUNTING

Frequency Counter

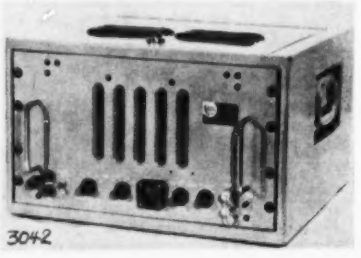
New "DS-6100" features size and weight reduction through new circuitry with fewer components. Range 10 to 100,000 events per second; time

base 100-kc. crystal-controlled oscillator circuit with five divider stages. Among features: automatic and manual gate control; automatic and manual reset; 0.5 to 6-sec. display time; fan-cooled. Weight 28 lbs. Accessories offered include tachometer pickup and photocell.—*The Detectron Corp.*, 5420 *Vineland Ave., North Hollywood, Calif.*

For more information circle **227** on inquiry card.

Frequency Counter

New "Model 111 Electronic Counter" will operate in ambient temperatures from –20 F. to 150 F. All components



No maintenance problems with this instrument!

In spite of all of the development work being done on automatic control instruments, the Bristol Series 500 Air-Operated Controller is still the most dependable and trouble-free — as proved by thousands of installations. And here's why:

It's the simplest to service. Only one adjustment with a ¼ in. wrench calibrates the control system. No other adjustment is needed. Control system can be completely disassembled and, after reassembly (even with replacement parts), can be *exactly calibrated by this one simple adjustment.*

It's completely reliable. One user states, "I'm amazed at the way this instrument performs day-in and day-out with little or no attention. We call it the work-horse controller in our plant. And our plant men like to use it, because it gives them the precision results they need without having to fuss with it".

Its settings are exactly reproducible. Reset rate, derivative time, and proportional band adjustments are accurately calibrated and exactly reproducible. You can instantly reproduce established settings without cut and try.

It uses the world-famous Bristol measuring elements. The measuring systems used in Bristol Series 500 Air-Operated Controllers for TEMPERATURE, PRESSURE, FLOW, VACUUM, DRAFT, ABSOLUTE PRESSURE, LIQUID LEVEL, pH, AND HUMIDITY are the result of 65 years of experience in instrument making and application in practically every industry. Bristol measuring elements are recognized the world over for their accuracy, simplicity, and reliability. There just aren't any better measuring elements made than Bristol's.

For more facts and figures about the Series 500 Air-Operated Controllers, write for free 32-page bulletin A120. The Bristol Company, 113 Bristol Road, Waterbury, Connecticut.

4.27

TRADE MARK
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BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **41** on inquiry card.

- **RESOLUTION: AS LOW AS 0.25%**
- **POWER RATING: 0.25 WATT AT 100° F.**
- **WEIGHT: ONLY 0.1 OZ.**

BOURNS ***TRIMPOT*** is a 25 turn, fully adjustable wire-wound potentiometer, designed and manufactured exclusively by BOURNS LABORATORIES. This rugged, precision instrument, developed expressly for trimming or balancing electrical circuits in miniaturized equipment, is accepted as a standard component by aircraft and missile manufacturers and major industrial organizations.

Accurate electrical adjustments are easily made by turning the exposed slotted shaft with a screw driver. Self-locking feature of the shaft eliminates awkward lock-nuts. Electrical settings are securely maintained during vibration of 20 G's up to 2,000 cps or sustained acceleration of 100 G's. BOURNS ***TRIMPOTS*** may be mounted individually or in stacked assemblies with two standard screws through the body eyelets. Immediate delivery is available in standard resistance values from 10 ohms to 20,000 ohms. BOURNS ***TRIMPOTS*** can also be furnished with various modifications including dual outputs, special resistances and extended shafts.

BOURNS *also manufactures precision potentiometers to measure Linear Motion; Gage, Absolute, and Differential Pressure and Acceleration*

BOURNS LABORATORIES

6135 MAGNOLIA AVENUE, RIVERSIDE, CALIFORNIA

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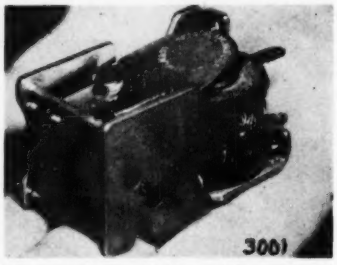
For more information circle **42** on inquiry card.

are military quality with hermetically sealed transformers, glass-sealed high-temperature capacitors, and computer-type tubes. Assembly withstands shock and vibration encountered in military field use. Frequency division is all-digital, using 11 plug-in decade scalers; no frequency adjustments required. Instrument will count up to 99,999 at rates up to 100,000 cps.; counting interval 1 sec. or 10 sec. with adjustable display time. Weight 120 lbs.—*Electronic Engineering Co. of Calif., 180 S. Alvarado St., Los Angeles 57, Calif.*

For more information circle **228** on inquiry card.

Magnetic Counter

New improved model of maker's completely flexible counter is adaptable to many industrial and experimental needs. Additive or subtractive,

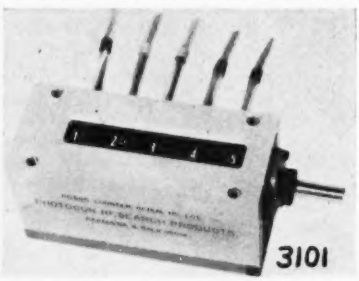


three or four digits with manually reset counter wheels; maximum recommended speed 1,200 counts per minute. Weight of counter mechanism 2 oz.; total weight in case 5 oz. Counters can be connected in vacuum tube plate circuits or operated by any contacting device; can be had with or without cases. Wound to any voltage from 6 to 110 dc.—*Abrams Instrument Corp., 606 E. Shiawassee St., Lansing 1, Mich.*

For more information circle **229** on inquiry card.

Telemetering Counters

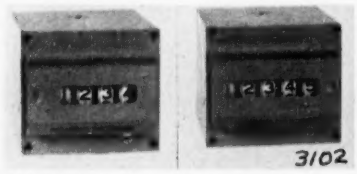
Two new series of telemetering counters register shaft rotation in either direction in increments of 1/10 revolution. "PC-500 Series Potentiometer Counters" have voltage-dividing resistor on each counter wheel with resistance ratios directly proportional to visual indication. "CC-500 Series Contacting Counters" have electrical contacts corresponding to each number on each wheel. Both are for remote indication and recording of data correlated photographically.—*Photocon Research Products, 421 No. Foothill Blvd., Pasadena 8, Calif.*



For more information circle **230** on inquiry card.

Magnetic Counters

New "Model MC-504 SZL" high-speed counter was developed to subtract magnetic impulses in digital control systems. It subtracts from 999.9 to 000.0 and opens or closes a Microswitch at zero level (000.0). Each wheel may be individually set to any predetermined number through a sliding window. ★ New "Model



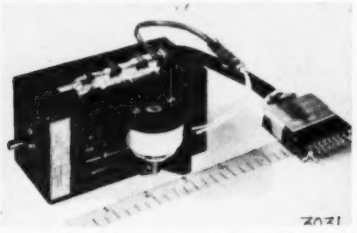
MC-505AS" five-digit high-speed counter adds and subtracts magnetic pulses in digital control systems when magnetic pulses are applied to "add" or to "subtract" terminals respectively. Each wheel may be individually set to any predetermined number.—*Photocon Research Products, 421 No. Foothill Blvd., Pasadena 8, Calif.*

For more information circle **231** on inquiry card.

COMPUTING

Digitizer

New "Digital Converter" converts shaft positions into electrical contact settings. Rotating contact arms do not engage stationary contacts during input shaft rotation: at read-out, a ro-

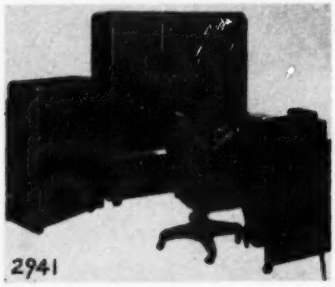


tary solenoid is energized to align and close contacts. Circuitry can be arranged so that current flows through contacts only while closed. Output is unambiguous and can be directly fed into card punch devices, tabulators, etc.—*Dayton Instrument, Inc., 404 Winston Ave., Dayton, Ohio.*

For more information circle **232** on inquiry card.

Decimal General Purpose Computer

New "CRC 102D" electronic data processing machine accepts data from an electric typewriter, punched paper tape, magnetic tape or punched cards. All data are entered into machine, operated on, and printed out in decimal form. New model is based on Computer Research Corp. "102-A" and retains that machine's small size, dependability and ease of maintenance.—*The National Cash Register Co., Electronics Div., Dept. 100, 3348 W. El Segundo Blvd., Hawthorne, Calif.*



For more information circle **233** on inquiry card.

Ternary Counter

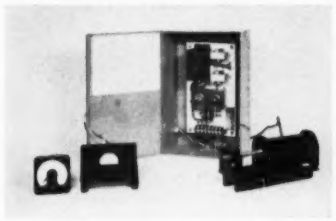
New "Type M2923" resin-encapsulated plug-in unit is said to be the first of its type ever produced commercially. It has three stable states: principle of operation same as Eccles-Jordan "flip-flop," except conduction of one tube in ternary counter prevents conduction of two other tubes. As a result, one of the three outputs is always at a voltage level different from level of other two. Input pulses cause "odd" output to advance in a sequential manner. Frequency range 0 to 100 kc. Negative driving pulses with an amplitude between 60 and 150 volts and a rise time from 0.5 to 1.5 usec. are required. Output at any of three plates is an amplitude of 80 volts peak to peak. Output rise time 0.4 usec.—*The Walkirt Co., 145 W. Hazel St., Inglewood, Calif.*

For more information circle **234** on inquiry card.

POSITION

Position Transmitter

New "Electric Position Transmitter for Linear Motion" enables operator of a rectilinear-motion machine to return machine to a previous position



within 1 percent accuracy. Components: position transmitter on machine, control panel at any convenient place, and indicating instrument located at operator's control station. Feature of transmitter is that rod tied to machine has no mechanical stop, thus eliminating breakage from overtravel. System will transmit total travel in ranges from 5/8 in. to 3 in.—*Control Products Co., Inc., Noblestown Rd., Oakdale, Pa.*

For more information circle **235** on inquiry card.

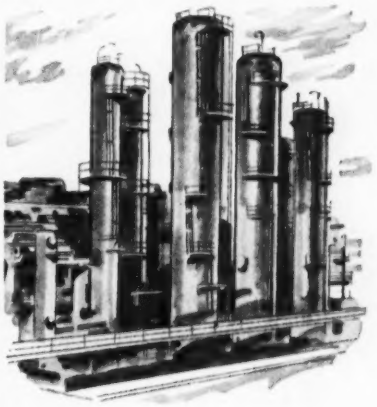
Remote Positioner

New "Electrolink" remote positioning system weighs 10.5 lbs.; extends useful power range of electric servomechanisms in aviation and industrial fields. Components: electric amplifier, transmitter Autosyn, and magnetic-

DE LUXE MODEL

$49,000,000.00

LEAK DETECTOR



While this leak-detecting device carries a $49,000,000.00 price tag, it is worth every penny of it! This device will not find leaks any faster than lower-priced models, but it will usually find more of them.

Leaks are expensive. Why not specify Swagelok Fittings and stop leaks before they happen?

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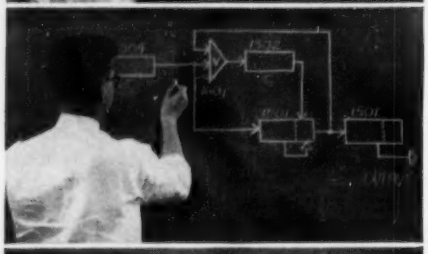
For more information circle **43** on inquiry card.

Engineer assembles pulse system in 30 minutes, using Burroughs "do-it-yourself" units

Standard, matched units, performing basic functions, connect together to form even the most complex pulse systems

1. START

Engineer studies time chart of the desired pulse sequence. This is the output he wants the pulse system to produce.

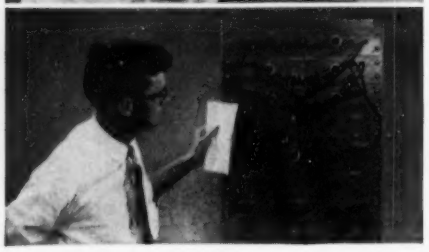


2. PLANNING THE SYSTEM

He determines which Burroughs units he needs and how they should be connected together. This can be done by means of a simplified block diagram. Time: 10 minutes.

3. ASSEMBLING THE UNITS

Using standard coaxial cables, he completes his pulse system by connecting the units together according to his block diagram. Time: 20 minutes.



4. JOB COMPLETED

System now produces the exact pulse sequence desired. Engineer saves weeks of breadboard engineering, vital time, uncertainty, and considerable equipment cost. And his Burroughs "Unitized" pulse handling equipment can be used over and over again on different future projects.

GET THE FACTS

No matter how complex the pulse sequence you need, you can produce it quickly and at relatively low cost with Burroughs "Unitized" pulse handling equipment. If you prefer, send us a timing diagram of the pulse sequence required, and we'll advise you what Burroughs units you need and the cost. Immediate delivery from stock. Write Burroughs Corporation, Electronic Instruments Division, Dept. 5 K, 1209 Vine St., Phila. 7, Pa.

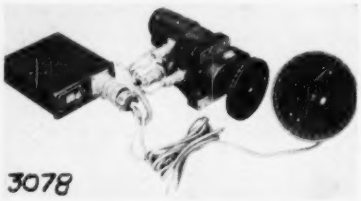
ELECTRONIC INSTRUMENTS DIVISION

Burroughs

FIRST IN PULSE HANDLING EQUIPMENT

For more information circle **44** on inquiry card.

NEW INSTRUMENTS



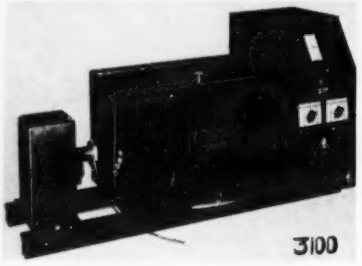
powder-clutch servo-drive with integral receiver Autosyn. Power sources required: 115 v. single-phase 400 cps., and 28 v.dc. Accuracy is within ¼ degree for most loads. Output torque 150 lb.-in. maximum at 25 rpm. without additional gear box (various gear ratios and motor combinations available); maximum power output 50 watts. A 60-cycle version will soon be available.—*Lear, Inc., Dept.* 80, *Grand Rapids* 2, *Michigan.*

For more information circle **236** on inquiry card.

LABORATORY

Photometer

New "1000 Series Brice-Phoenix Universal Light Scattering Photometer," improved version of "B-S Light Scattering Photometer," is a self-con-

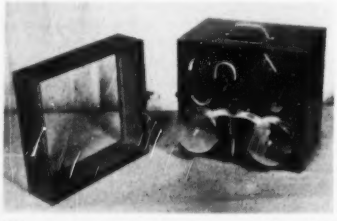


tained instrument for measuring micro-scattering, micro-fluorescence, micro-luminescence, low transmittance and reflectance; also absolute turbidity, dissymmetry and depolarization of dilute solutions of high molecular weight compounds.—*Phoenix Precision Instrument Co.,* 3803 *N. Fifth St., Philadelphia* 40, *Pa.*

For more information circle **237** on inquiry card.

Automatic H_2S Sampler

New "A. I. S. I. Automatic Hydrogen Sulfide Sampler" indicates H_2S concentration as low as one part per



billion parts of air; is a modification of maker's "Automatic Smoke Sampler" using a sensitized tape for H_2S samples (other tapes to be developed in the future).—*Research Appliance Co., Box* 463, *West View Rd., Pittsburgh* 9, *Pa.*

For more information circle **238** on inquiry card.

Falling-ball Viscosimeter

New simplified falling ball viscosimeter provides a rapid and easy means for determining viscosity of any liquid up to 40,000 centipoises. Its light weight (less than 11 oz.) makes it suited for lab, shop or field use. It comprises a precision-bore glass tube in a metal housing with viewing windows at each end; and a built-in thermometer. To use, tube is filled with test liquid; ball is inserted; end cap is replaced and instrument is turned upside down. Centipoises equal falling time in seconds times ball constant. By turning instrument over repeatedly, any number of readings may be taken in series. Conversion tables are supplied with instrument.—*National Instrument Co., 5005 Queensbury Ave., Baltimore 15, Md.*

For more information circle **239** on inquiry card.

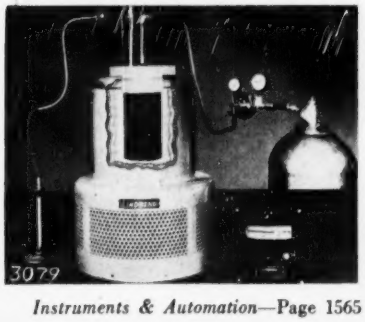
Flash Tester

New closed cup flash tester, for ASTM D-56 tests, embodies built-in "Powerstat" heat control, die-cast aluminum base, aluminum hot plate, stainless steel test burner tip, nickel plated finish. Body can be removed without tools for rapid cooling.—*Labline, Inc., 217-221 N. Desplaines St., Chicago 6, Ill.*

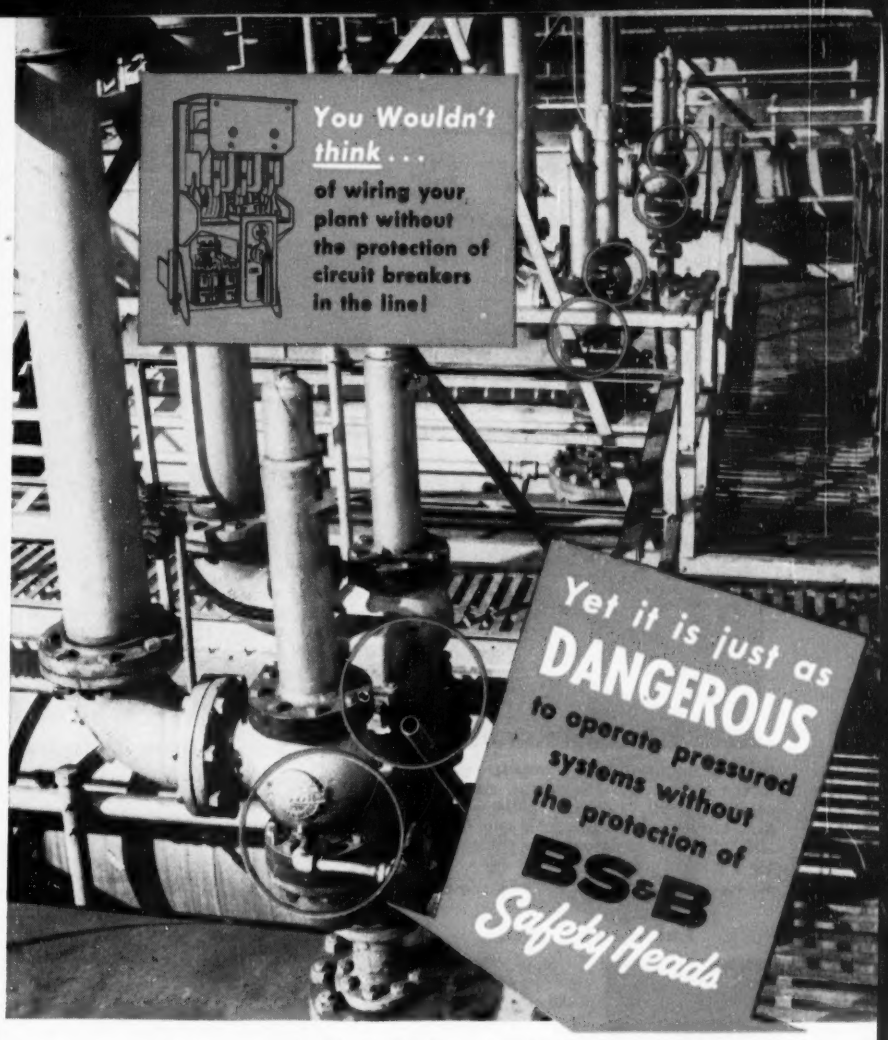
For more information circle **240** on inquiry card.

Dissociated Ammonia Generator

New "Lab-Hyam," first commercial laboratory size dissociated ammonia generator, has 35-15 alloy catalyst chamber with a vertical inlet and a vertical outlet tube designed to fit into maker's laboratory pot crucible



Circle **45** on inquiry card. ⟶


You Wouldn't think . . .
of wiring your plant without the protection of circuit breakers in the line!
Yet it is just as DANGEROUS to operate pressured systems without the protection of
BS&B Safety Heads

Just as an electrical circuit breaker protects your personnel, plant and equipment from electrical overloads, shorts and "burn-outs", so does the BS&B Safety Head protect them from the dangers of overpressure in pressured systems.

The BS&B Safety Head is a patented pressure relief device that is designed to become an integral part of any pressured system containing air, gas or liquid—either bland or corrosive.

The rupture disc of the BS&B Safety Head is custom fabricated to the specific requirements of the system of which it is a part. It provides a full pipe-sized vent for *instantaneous* relief before the pressure exceeds the safety limits of the system.

The BS&B Safety Head is especially suited to use in oil and gas producing fields, pipe lines, refineries, chemical plants, power plants and the refrigeration industry. It may be used as either a primary or secondary relief device, and either upstream or downstream from a relief valve, as varying conditions may require.

If you aren't already using BS&B Safety Heads in *your* plant, we'd suggest you get in touch with your nearest BS&B representative without delay. Or write for complete BS&B Safety Head Catalog. There's no obligation.

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THE "CIRCUIT-BREAKER" OF *Any Pressured System*

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SAFETY BS&B HEADS OVER 60 YEARS

furnace, welded to form a gas-tight unit. Pure nickel shot surround tubes within the catalyst chamber; 99.90% dissociation is accomplished at 35 cfh. No air is used in dissociating process. Atmospheres equivalent to commercial cylinder hydrogen are said to be produced for approximately 1/3 its cost. —*Laboratory Equipment Div., Lindberg Engineering Co.*, 2450 *W. Hubbard St., Chicago* 12, *Ill.*

For more information circle **241** on inquiry card.

Colorimeter

New "Davis-Bruning Colorimeter" eliminates problem of color drift by furnishing permanent color standards;

utilizes magnesium carbonate screen, mixed light from a series of standard color plaques, variable shutter, and direct-reading drums.—*Fisher Scientific Co.*, 717 *Forbes St., Pittsburgh* 19, *Pa.*

For more information circle **242** on inquiry card.

Laboratory Mill

New "Number 2" centrifugal wet mill combines functions of grinding, comminuting, mixing, extracting, dissolving and homogenizing of sample particles in solid form, as well as fluid and solid mixtures; is particularly applicable to reduction of oil bearing seeds for analytical determination of oil content. Height of mill assembly 19 in.; approx. wgt. 25 lbs.—*E. H. Sargent & Co.*, 4647 *W. Foster Ave., Chicago* 30, *Ill.*

For more information circle **243** on inquiry card.

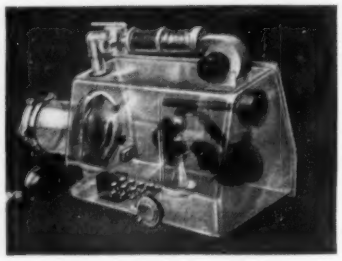
Bench-model Demineralizer

New "Model L-20" bench model demineralizer requires 15 x 8 in. of counter space; is of regenerative type; will supply up to 20 gph. of "super high purity" water at a chemical cost of pennies per 100 gal. Unique "Dual Action" design enables two columns to do the work of four. Flow control system keeps incoming flow constant at not over 20 gph. Penfield conductivity meter gives continuous visual indication of purity of effluent. Unit is shipped assembled, including regenerated resin charges.—*Penfield Mfg. Co., Inc.*, 19 *High School Avenue, Meriden, Conn.*

For more information circle **244** on inquiry card.

Plastic Hood

New control hood (back-view shown) is of type formerly custom-made; is said to be the first low-cost light-weight isolation and atmosphere



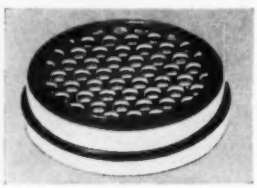
control hood made of a crystal clear plastic material. New plastic is chemically inert, has complete stability at 450 F., craze and mar-proof, 1/20 weight of similar stainless steel housing and ⅛ weight of glass.—*P. M. Lennard Co., Inc.*, 671 *Bergen St., Brooklyn* 38, *N. Y.*

For more information circle **245** on inquiry card.

NUCLEONICS

Alpha Scintillation Detector

New light-tight scintillation detector counts alpha particles but not other radiations; contains a closely-packed monolayer of alpha sensitive phosphor



covered by aluminum foil (0.7 to 1.0 mg. per sq. cm.) transparent to alpha particles but not to light. Assembly is interchangeable with counters for beta rays, gamma rays and neutrons. A perforated screen protects thin foil from accidental damage.—*National Radiac, Inc.*, 10 *Crawford St., Newark* 2, *N. J.*

For more information circle **246** on inquiry card.

Survey Counter

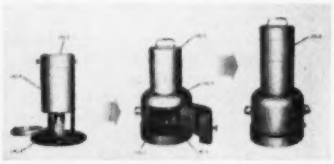
New "Model GC-238 Prospector," said to be "the first commercially-available Geiger counter employing a patented printed circuit," weighs 2¾

lbs.; features three methods of indication: aural, flashing neon light, and indicator having three ranges: 0-0.2/2/20 mr./hr. full-scale; detects beta particles and gamma rays.—*The Radiac Co., Inc.*, 489 *Fifth Ave., New York* 17, *N. Y.*

For more information circle **247** on inquiry card.

Universal Shield

New "Model 14L Universal Shield Assembly" includes matched sections designed to solve familiar problem of accumulated dead weight of shields



in various shapes and sizes. Essentially, it is a set of building blocks. At left is minimal 3-piece assembly for well counting; at center is an assembly for window-down counting of samples in a completely shielded chamber; complete assembly (right) has all properties of both partial shields, plus a large fully-enclosed chamber at top for window-up counting of large samples. Average background of scintillation well counters is reduced to 3 cps.—*R-C Scientific Instrument Co., Inc.*, 307 *Culver Blvd., Playa del Rey, Calif.*

For more information circle **248** on inquiry card.

Beta Scintillation Counter

New light-tight scintillation counter counts beta particles but is relatively insensitive to gamma rays and neutrons; is interchangeable with others for alpha rays, gamma rays and neutrons.—*National Radiac Co.*, 10 *Crawford St., Newark, N. J.*

For more information circle **249** on inquiry card.

Introductory Scaler

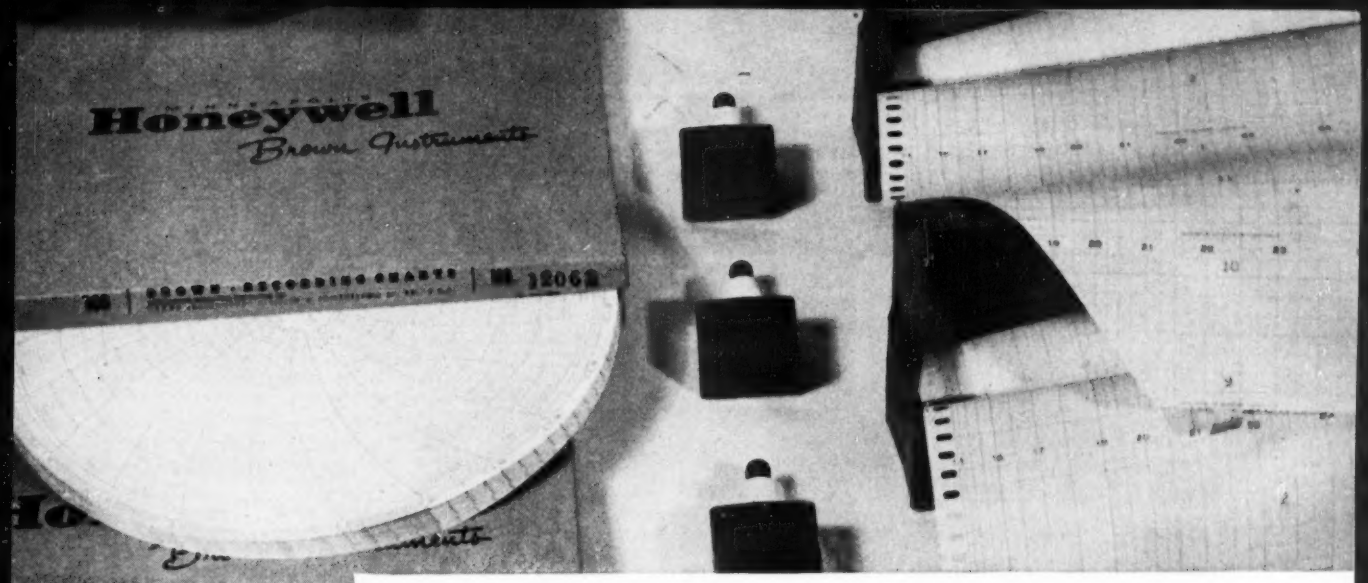
New "Model A-65 Introductory Scaler," for use with any counter operating in Geiger region, features: well-regulated high-voltage power supply; high-voltage warm-up protection; plug-in interchangeable scaling stages having a resolution of less than 5 usec.; provision for preset time, elapsed time, and count rate-meter operation.—*The Atomic Center for Instruments & Equipment, Inc.*, 489 *Fifth Avenue, New York* 17, *N. Y.*

For more information circle **250** on inquiry card.

Liquid Sample Counter

New "SC-12 Liquid Sample Attachment," incorporated with "SC-3 Basic Unit" and "LH-6 Lead Shield," was designed for counting low-level activity in small-volume liquid samples (up to 5 cc.) Background is reduced to approx. 200 counts per minute, at the same time giving a sensitivity of 1000 counts per minute for one millimicrocurie of I-131. Estimated efficiency for a small sample of I-131 is 50 percent of all gamma rays emitted. A full 2 in. of lead completely surrounds counter and sample in normal counting position. Unit accommodates different bottle

Circle No. **46** on inquiry card. ⟶



NEW recorder charts!

NEW inks!

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Meet the brand new line of Brown recorder charts and inks . . . the finest "team" ever developed to give you the peak in recording performance on your Brown instruments.

The new strip and circular charts are made of the highest grade pulp, quality-controlled for perfect appearance and texture. They're given a special internal and external sizing to produce a superior writing surface that won't feather or strike through. Stretching and shrinking due to changes in humidity are practically eliminated.

The new inks are custom-made to write sharp, clear records on the new papers. They dry quickly . . . yet give minimum evaporation in the pen reservoir. A selection of brand new colors is available, including a deep black suitable for blueprint reproduction.

Ask your local Honeywell Supplies Man about these new papers and inks . . . and about the economical, convenient HSM Plan for purchasing pyrometer supplies. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

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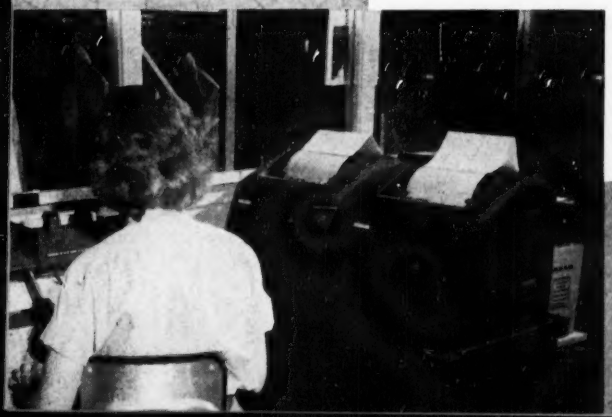
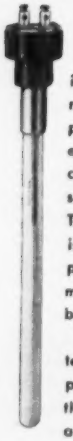
BROWN INSTRUMENTS
First in Controls

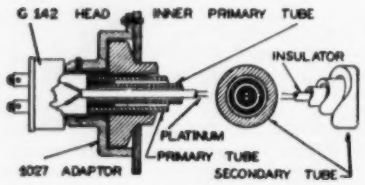


Fast Service on your orders for charts, and other pyrometer supplies, is expedited by this teletype equipment at Honeywell stock headquarters.



A background of many years of experience and "know-how" go into the production of Gordon Platinum, Platinum-Rhodium Thermocouples. From this experience has evolved the Gordon policy which calls for the utmost in quality and service, the utmost in value to clients. That is why Gordon platinum wire is carefully checked for thermocouple accuracy against a master thermocouple... calibrated and certified by the National Bureau of Standards.

The porcelain insulation and protecting tubes which go into a complete thermocouple assembly are of the finest quality obtainable. They are the best known means of preventing contamination of the elements which result in false e.m.f. values. Also, the Gordon G-142 head which goes



into a complete thermocouple assembly is light in weight and permits easy replacement of new elements into a protecting tube assembly.

The Gordon Policy—highest quality and standards of material — plus Gordon craftsmanship at the lowest possible price.

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Dept. 21 • 2035 Hamilton Ave., Cleveland 14, Ohio

For more information circle **47** on inquiry card.

NEW INSTRUMENTS

heights and shielding is preserved for sample bottles greater in height than depth of well.—*Nuclear Research & Development, Inc., 6425 Etzel Ave., St. Louis 14, Mo.*

For more information circle **251** on inquiry card.

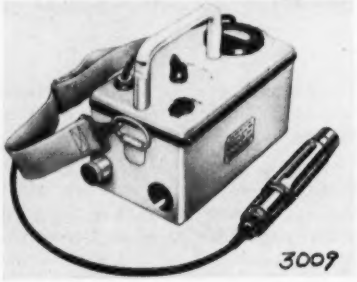
Ionization-type Monitor

New "Model 2582 Samson" is a self-contained battery-operated ionization type survey instrument for surface measurement of any low-level alpha, beta, or gamma contamination. Feature: 40 cu. in. ion chamber at bottom of case with a 0.5 mg/cm^2 rubber hydrochloride window protected by a stainless steel grill. Three alpha ranges: 0 to 12,500 counts per minute. "Samson" will detect alphas with energies as low as 1 mev. or betas with energies as low as 15 kev.—*Nuclear Instrument and Chemical Corp., 229 W. Erie St., Chicago 10, Ill.*

For more information circle **252** on inquiry card.

CD and Lab Geiger Counter

New "Model DG-700 Beta-Gamma Discriminating Radiological Survey Meter" meets Federal Civil Defense



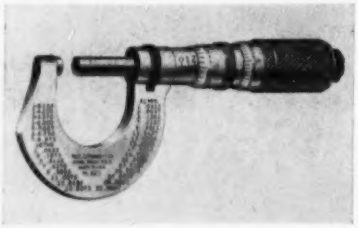
Administration specs, is for use by CD personnel in measuring low-level beta-gamma radiation; can also be used for general radiological protection and for routine non-disaster use. —*Atomic Center for Instruments & Equipment, Inc., 489 Fifth Ave., New York 17, N. Y.*

For more information circle **253** on inquiry card.

DIMENSIONAL

"Tenths" Micrometer

New "Hi-Precision" micrometer caliper reads direct in ten-thousandths of an inch (no vernier); also makes every measurement with right spindle



pressure (no relying on "feel"). Feature is maker's unique "Hi-Precision" thimble consisting of an inner thimble reading in thousandths and an outer thimble with widely-spaced graduations in ten-thousandths. Accuracy throughout 0-to-1-in. range is within 0.00005 in.—*L. S. Starrett Co., Athol, Mass.*

For more information circle **254** on inquiry card.

"Tenths" Micrometer

New "Microfix" (made in Germany) features "continuous flow reading" in ten-thousandths; guaranteed accuracy within 0.0001 in. It is said to eliminate mental arithmetic because each grad-

uation is marked with its value: Tenths are read on sleeve (barrel); hundredths in window; thousandths on drum and ten thousandths on vernier. No parallax because barrel and thimble are located on one plane. Insulated drum grip and insulation plates on frame reduce hand heat effects.—*Karl A. Neise, 404 Fourth Ave., New York 16, N. Y.*

For more information circle **255** on inquiry card.

Surface-roughness Scales

New cylindrical surface roughness scales, designed as standards of comparison by sight and touch for internal and external curved surfaces, comprise two scales each, 6 in. wide

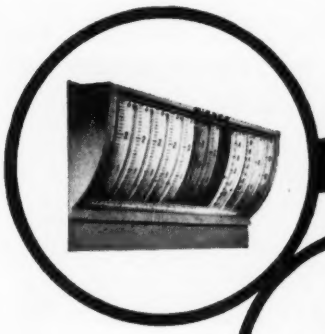
and 2 in. long. Scale No. 1 is for determining surface roughness of ten specific surfaces in 4, 8, 16, 32 and 63 microinch categories, both external and internal. On scale No. 2, typical surfaces produced by lathe and screw machine operations in 16, 32, 63 and 250 microinches values are represented by turned as well as bored surfaces. —*General Electric Co., Schenectady 5, N. Y.*

For more information circle **256** on inquiry card.

Four-dimension Gage

New production gaging instrument inspects four dimensions simultaneously on carrier body of automatic transmission. When all four are within tolerance, master light remains white and all four signal lights on panel black out. However, if one or more of dimensions are out of tolerance, master light turns red and signal lights turn either red (for

one of these

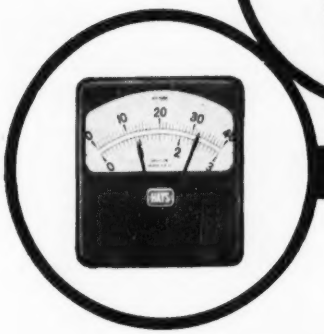


W-Gage for large boilers and remote indication

Hays gages

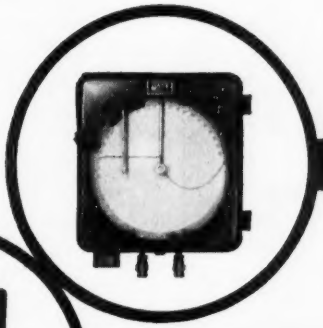
B-Gage for small boilers, combustion testing and air filters

will meet your



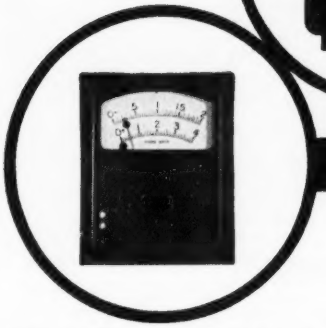
FOT-Gage for furnace pressure or fuel flow – air flow indication

LOW PRESSURE



OT-Recorder for draft or pressure

requirements



D-Gage for commercial, institutional boilers and industrial furnaces

Whether you need a draft gage for the largest steam generator, or a small portable gage for spot checking pressure conditions, first or last, it will pay you to talk to Hays, manufacturer of the most complete line of draft and low pressure gages.

Functional in styling, Hays gages have the features instrument men have always asked for—easy to read, accessible and extremely dependable.

The heart of all Hays low pressure gages is a diaphragm housed in cast metal. Diaphragms are easily replaceable in the field.

All Hays gages are guaranteed to withstand at least 100% over range without failure!

Why not talk to the people at Hays about low pressure gages for your applications—or write for complete details: *Bulletin 54-667-8.*

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Combustion Test Sets
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Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

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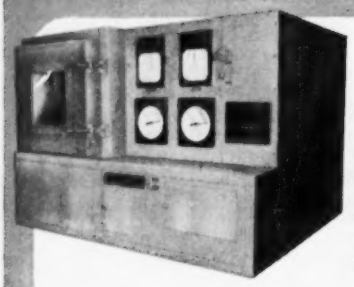
For more information circle **48** on inquiry card.

FOR ENVIRONMENTAL TESTING

Tenney

. . . for Tenney Test Chambers are precision-engineered for maximum efficiency and can be designed to simulate the complete range of temperature, atmospheric or pressure conditions found anywhere on earth — or above it to altitudes of 120,000 ft. plus! They attain sub-zero temperatures quickly, maintain them efficiently and provide full instrumentation for accurate evaluation of complete test data.



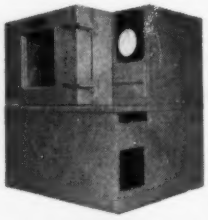
TENNEYZPHERE ALTITUDE CHAMBERS

Designed to withstand atmospheric pressure and to simulate global conditions of pressures, temperatures and humidities. Altitudes from sea level to approx. 80,000 ft. Temperature range from plus 200° F. to minus 100° F. Also simulates desired (20% to 95%) relative humidity.

TEMPERATURE AND HUMIDITY CHAMBERS

Model TR — Precision recorder controllers permit accurate simulation and check of temperatures to +200° F. Meets all Mil and JAN specs for low- and high-temperature requirements by incorporation of temperatures down to −100° F. Humidities within 20%-95% range. Variety of standard sizes.

Model TH — Designed for a temperature range of +35° F. to +185° F., and a humidity range of 20% to 95%. Accurately simulates, controls, and checks all above-freezing temperatures. Program control to meet a wide variety of Mil specs optional. Manufactured in a wide range of standard sizes.



TENNEY SUB-ARCTIC INDUSTRIAL CABINETS

Designed for low-temperature testing of metals, radios, instruments, plastics, liquids, chemicals and pharmaceuticals. Temperature ranges of −40° F., −80° F., −100° F., −120° F., −150° F., −170° F., are standard for each size.

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West Coast Representative: The Thorson Company, 1644 N. Orange Ave., Los Angeles 46, Calif.

Engineers and Manufacturers of Automatic Environmental Test Equipment

For more information circle **49** on inquiry card.

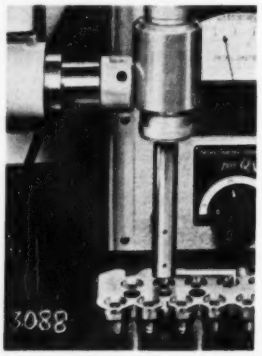
NEW INSTRUMENTS

undersize) or green (oversize); lights of correct dimensions black out.—*The Sheffield Corp., Dayton 1, Ohio.*

For more information circle **257** on inquiry card.

Surface Roughness Tracer

New "Profilometer Type GC Tracer," for measuring surface roughness across bottom of flat-bottomed grooves and slots to ¼-in. depth and

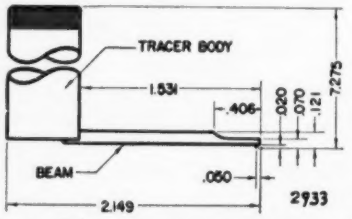


behind shoulders to ¼-in. height, measures lengthwise in slots as narrow as 5/64 in.; can also be used in ID's from 25/64 in. to flat, and on all other internal and external surfaces where geometry of work permits and where part can be mounted with work surface approx. horizontal.—*Micrometrical Mfg. Co., 345 S. Main St., Ann Arbor, Mich.*

For more information circle **258** on inquiry card.

Small-hole Tracer

New "Type GK Tracer" is for use with maker's "Profilometer" for taking surface roughness measurements



in small holes, in narrow grooves and slots, and on small parts (or small areas on larger parts) particularly where the dimensions involved are less than ¼ in.—*Micrometrical Mfg. Co., 345 S. Main St., Ann Arbor, Mich.*

For more information circle **259** on inquiry card.

Surface Plate Stands

New steel stands for black granite surface plates range in size from 12 x 18 in. through 72 x 144 in. They are

made of heavy gage angle iron reinforced to withstand 3 to 6 times weight of respective surface plates. Working height is 36 in.; others if specified.—*Collins Microflat Co., 2326 E. 8th St., Los Angeles 21, Calif.*

For more information circle **260** on inquiry card.

Torque Wrenches

New "Hi Lo Torq" wrenches meet all requirements of Mil. Spec. H-4034-A, hence of quality control men

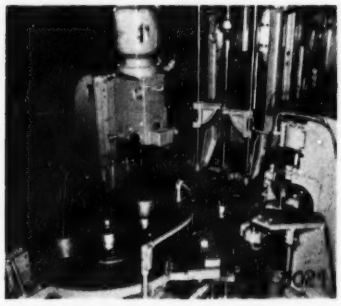
in plants handling military contract work; are available with reversible ratchet heads, or with plain square drive, and in capacities to meet every practical machine assembly need.—*Richmont Inc., 922 So. Myrtle Ave., Monrovia, Calif.*

For more information circle **261** on inquiry card.

MACHINE AUTOMATION

Three-station Machine

New automated 3-station machine comprises a drill unit, a broaching machine, and a stamping unit. All individual operations are performed on

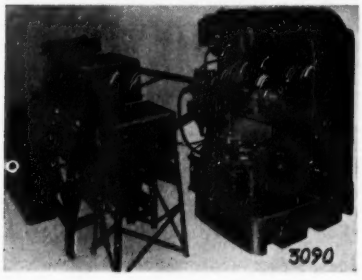


one common base in one continuous cycle. All three machining operations are grouped around "heart": loading and indexing mechanisms. Included in loading and indexing fixtures are locating guides that maintain all three operations in proper relationship to one another. Hydraulic unloader deposits completed parts onto a conveyor.—*Colonial Broach Co., Detroit, Mich.*

For more information circle **262** on inquiry card.

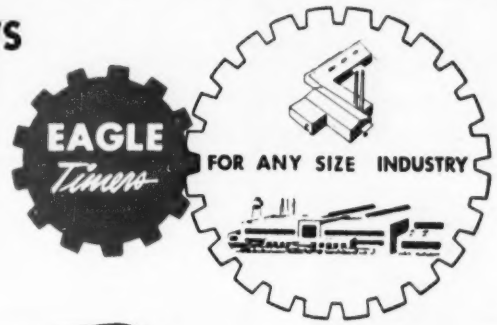
Automatic Gear Machine

New fully automated gear production machine shaves, inspects and sorts spur or helical gears at high production rates. It includes vibrating hopper and straight-line feeder, automatic "in" and "out" gages, automatic loader, standard diagonal-type "Red Ring" rotary gear shaving ma-

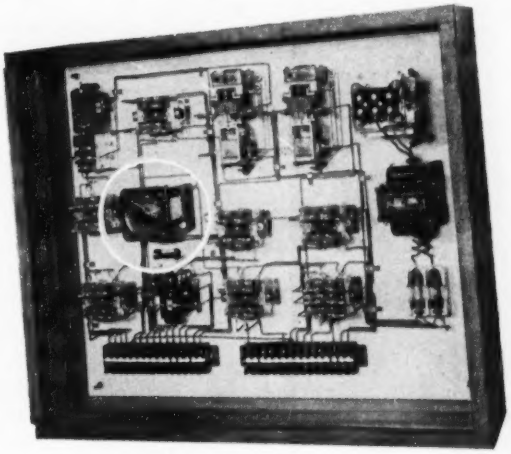


Automation

STARTS WITH



WELDING



The Eagle Cycl-flex Reset Timer meets the specific requirement needed for more flexible control of the Peck Automatic Welder. The Cycl-flex with its flexible time and electrical control features made it the ideal timer for regulating the proper "overlap" and "arc cutoff" phases of the cycle. The timer is easy to set — easy to read — it has cycle progress indication.

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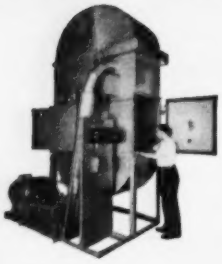
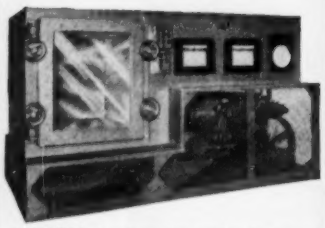
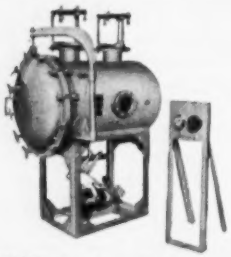


SAND & DUST test chambers with completely automatic dust density control.



ALTITUDE chambers for testing from sea level to 100,000 ft. or higher with temperatures from −100° F to +200° F, relative humidity from 20% to 100%.



EXPLOSION chamber with double safety features for testing under explosive atmosphere conditions up to 50,000 ft.

American Research offers a complete line of Environmental Test Equipment for simulating conditions of high and low temperature, altitude, relative humidity, sand and dust, rain and sunshine, fungus, explosion, etc.
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For more information circle **51** on inquiry card.

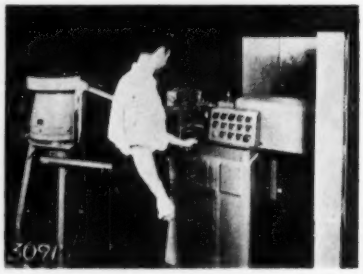
NEW INSTRUMENTS

chine, and discharge belt conveyor unit. Automatic gages shut down machine if it receives or produces too many reject parts. Signal lights tell setup man what is wrong and thus minimize machine down-time. Automatic loader, (air-powered rocker-type) positions gears one by one in cutting position beneath shaving cutter in shaving machine; machine goes through its cutting cycle; unloading finger picks up finished gear and directs it to "out" gage. If desired, "out" gage can shut machine down based on production of a specified percentage of a given type of reject parts.—*National Broach & Machine Co., 5600 St. Jean Ave., Detroit 13, Mich.*

For more information circle **263** on inquiry card.

Automatic Gear Inspector

New "Model GSC Red Ring Automated Gear Speeder Inspection Unit" completely eliminates all manual loading, unloading and control functions. Operator listens to sound of production gears as they are rotated in contact with a master gear, and diverts any gears from unloading chute which do not meet inspection standards for sound. Pushbutton controls facilitate setup operations. Air cylinders control work arbor, loader and brake functions.—*National Broach & Machine Co., 5600 St. Jean Ave., Detroit 13, Mich.*



For more information circle **264** on inquiry card.

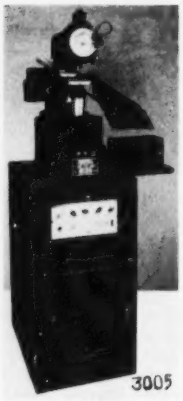
MECHANICAL TESTING AND INSPECTION

Projected-indentation Hardness Testers

New reflex machines for Vickers, Knoop, Grodzinski, Brinell and (optional) Rockwell tests, feature unusual test load capacities (from 1 to 250 kg.), push-button load selection, and automatic projection. Load selection is simple and rapid: all weight blocks remain permanently in machine; operator simply presses push button for particular test-load desired. After test-load has been removed, magnified (up to 140) image of indentation is automatically projected on ground glass screen. Glass can be replaced by a photographic plateholder.—*Gries Industries, Inc., Testing Machines Div., New Rochelle, N. Y.*

For more information circle **265** on inquiry card.

Automatic Hardness Tester

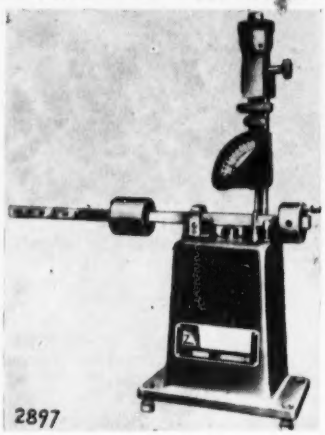


New fully-automatic "Rockwell" hardness tester is capable of performing between 1000 and 1200 tests per hour. Pieces being tested are power fed into tester and automatically placed in position beneath a diamond penetrator. Testing loads are applied and removed, and hardness indicated on a dial. Photoelectric transistors pick up this hardness indication, converting reading to impulses which actuate relays, which in turn classify material. Classifying units may be set so that hardness limits as close as two points may be controlled.—*Wilson Mechanical Instrument Div., American Chain & Cable Co., New York 17, N. Y.*

For more information circle **266** on inquiry card.

Hardness Testers for Elastomers

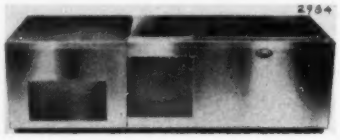
New models of "Durometers" and companion "Control Instrument Z-224" (made in Germany), for measuring hardness and elasticity of rubber and other pliable materials in accordance with ASTM specifications, are offered in various capacities to determine a full range of hardness values in Shore units.—*William J. Hacker & Co., Inc., 82 Beaver St., New York 5, N. Y.*



For more information circle **267** on inquiry card.

High-low Temperature Unit

New "Model No. A-2-1-80-200 FH" chest-type test chamber for high-volume production testing electronic equipment has two 1-cu. ft. compartments, each with temperature range of −100 F. to 200 F. and gradient



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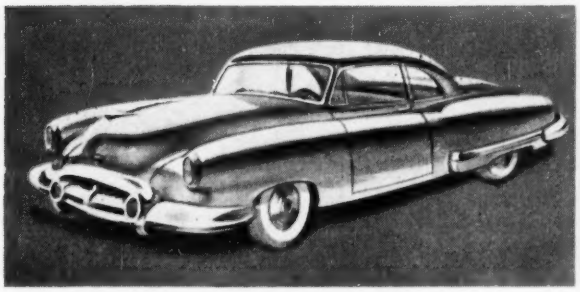

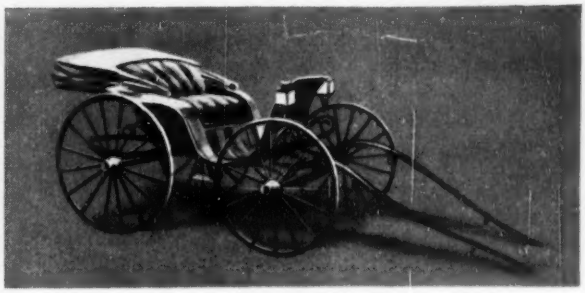

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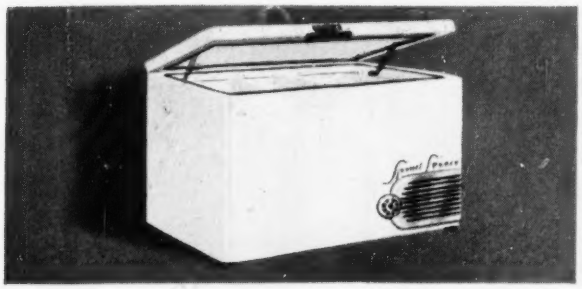
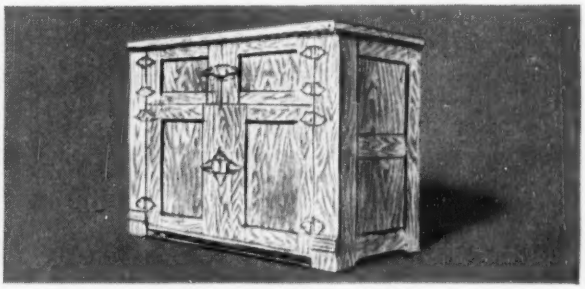
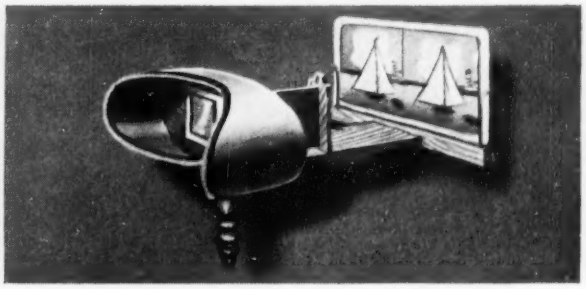




You have this . . . . . *Instead of this*



You have this . . . . . *Instead of this*

Advertising Benefits Everyone

The credit for the many wonderful products of our "American Way of Life" must be *divided*. The Inventor, the Investor, the Businessman, the Worker—all rightfully share that credit. **BUT** . . . it is *Advertising* that tells the story of the product; it is *Advertising* that whets public appetite for the product; and it is *Advertising* that helps sell the product. **AND** . . . the more product-demand that Advertising builds, the more products must be manufactured. That means Mass-Production which, in turn, means better products at lower prices. In short, a *still higher* American living standard. **SO** . . . *everyone* benefits. Industry, Business, Labor, Agriculture. But, most important of all, YOU the citizen.

And all with the help of Advertising!

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DALOHM Ω

Miniature POWER Resistors

Carefully crafted for matchless performance, Dalohm miniature power resistors are made to survive the most severe environmental, shock, and vibration conditions.

Also Available RH-250—250 Watts
RS Types—2, 5, and 10 Watt

Dalohm RH type resistors are completely welded from terminal to terminal. They are silicone sealed in a die-cast, black anodized radiator finned housing and mount on subpanel for maximum heat dissipation.

- Temperature coefficient 0.00002/Deg. C
- Ranges from 0.1 Ohms to 55,000 Ohms, depending on type
- Tolerance 0.05%, 0.1%, 0.25%, 0.5%, 1%, 3%, 5%
- Manufactured in accordance to JAN-R-26A Specifications, Characteristic G

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DALE PRODUCTS, INC.
Columbus, Nebraska, U.S.A.
Distributors

For more information circle **53** on inquiry card.

3 INSTRUMENT HOUSINGS
accommodate 85% of installations

Shipped knocked-down in heavy corrugated cartons for low shipping cost; easy handling; convenient storage.

Adaptable to field modification. Features 4" knockout in each side and back—¼" wire glass window in door. Dimensions:

Type R-50	2'6"	H	x 2'	x	1'6"
R-100	4'3"	H	x 2'	x	2'
R-200	5'3"	H	x 2'	x	2'

Construction is reinforced 18 gauge sheet, with 3/16" bottom plate. Housings are neoprene weather-proofed. Insulation is 1/2" foil-face fiberglas.

Bottom plate has hole to facilitate mounting. Heavy sleeve flange, setscrewed, holds 2" mounting pipe in hole.

Four screws in each panel make assembly easy. To remove any panel, disengage screws.

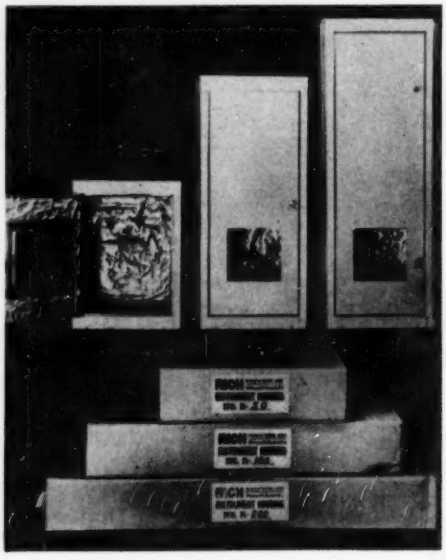
Union labeled to prevent labor disputes.

Zinc cromate primed inside and out. Hammertone gray finished exterior.

Fin type 12" steam heating unit with mounting bracket optional.

Will accept modifications that do not change basic dimensions.

By far the best constructed housing offered to the industry today for prices equal or less than inferior units.



RICH MANUFACTURING CORP.
250 Second Street, Elizabeth, N. J.

For more information circle **54** on inquiry card.

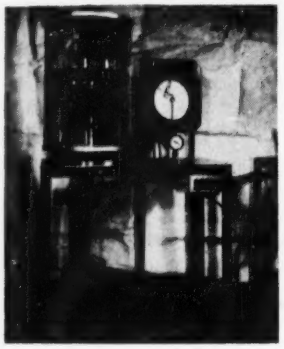
NEW INSTRUMENTS

temperature variation of less than 0.5 deg. at any point within chambers. Proportioning temperature control instrument assures control of temperature to 0.5 deg. Accelerated temperature changes are accomplished by recirculating air through chamber and over refrigeration coils or heating elements, changing air 500 times per minute. Test chambers may operate independently of each other even at extreme temperature differences. Standard chamber copper; other materials optional.—*Dep't N-469, Webber Mfg. Co., 2740 Madison Ave., Indianapolis 3, Ind.*

For more information circle **268** on inquiry card.

Altitude Chamber

New altitude chamber controls and records pressures for simulated altitudes of 25,000 to 100,000 ft. All units

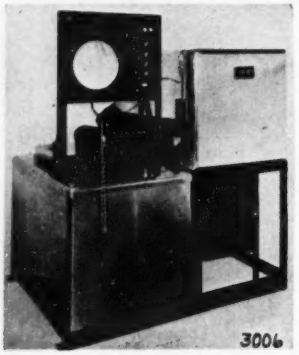


engineered to meet customer requirements.—*Optical Film Engineering Co., 2737 North Sixth St., Philadelphia 33, Pa.*

For more information circle **269** on inquiry card.

Low-temperature Cabinet

New low-temperature test cabinet, designed for occasional testing and where power supply is limited or no

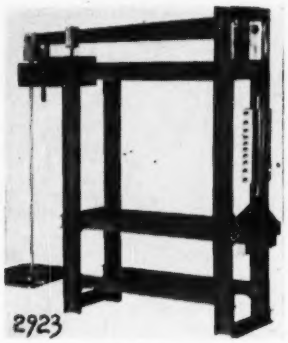


water is available for cooling freon, utilizes dry ice placed in a holding tank and immersed in brine. Brine is then circulated through cooling coils in test space.—*American Research Corp., 11 Brook St., Bristol, Conn.*

For more information circle **270** on inquiry card.

Stress-rupture Apparatus

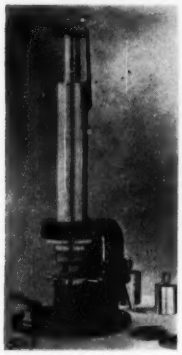
New creep and stress-rupture frame assembly has accuracy of lever system guaranteed to 0.5 percent. Shock absorber takes impact when specimen



ruptures, preventing damage to knife edges and seats. Safety stop restrains lever if an overload is applied. Elevating screw permits one-man placement and adjustment (motorized elevating mechanism with automatic follow of shock absorber available). Standard frames 12,000, 5,000, and 2,500-lb capacity (specials for other loads or for compression testing). Recording or indicating potentiometer controller for furnace can be supplied. —*Labquip Corp.*, 3521 *N. Cicero Ave., Chicago* 41, *Ill.*

For more information circle **271** on inquiry card.

Smoothness Tester

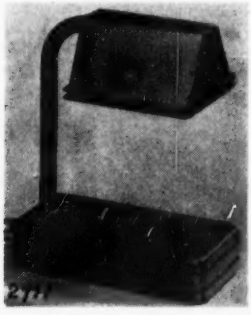


New "H-P-S Tester is a high-pressure porosity and smoothness testing instrument for measuring smoothness of single sides of paper, paperboard and paper products; permits testing felt and wire sides separately. Testing times for porosity are 4 percent of time required on standard "Densometer" or "S-P-S Tester"; and are the same as those on "High-Pressure Densometer."—*Industrial Division, W. & L. E. Gurley, Troy, N. Y.*

For more information circle **272** on inquiry card.

U-v. Inspection Lamp

New "Model 3X-4 Blak-Ray" is improved model designed for use in difficult inspection procedures, flaw



and invisible-marking detection; and for agricultural-products examination and inspection.—*Ultra-Violet Products, Inc., South Pasadena, Calif.*

For more information circle **273** on inquiry card.

Vibration Testers

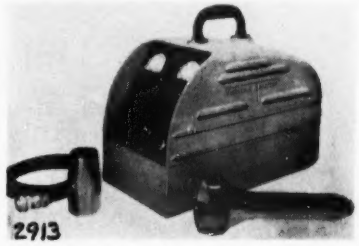
Two new models of maker's vibration fatigue test machines have 150-lb. capacity. "Model 150 HLA-D" produces vibration horizontally in simple harmonic motion; "Model 150 VA-D"

produces vibration vertically in simple harmonic motion. Both feature "Range Selector," a new type of automatic frequency control: acceleration changed automatically. After finding critical range, parts undergoing test may be held at that range to determine final breakdown point. "Range Selector" may be shut off and cycling operated manually.—*All American Tool & Mfg. Co.*, 8027 *Lawndale Ave., Skokie, Ill.*

For more information circle **274** on inquiry card.

Vibration Analyzer

New "Model 400" portable (24-lb.) vibration analyzer, capable of balancing rotating parts at speeds up to

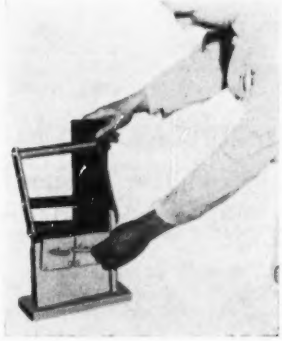


5,000 rpm. and of tracing any vibration up to 20,000 cpm., is designed to eliminate vibration in production machinery and to simplify maintenance of plant equipment through dynamic balance of rotating parts. Three ranges: 0-0.001/.01/.1 in. full-scale. Both direct and filtering-type probes come with seismic-type pickup.—*International Research & Development Corp.*, 168 *E. Hosack St., Columbus 7, Ohio.*

For more information circle **275** on inquiry card.

Flexibility Tester

New "Improved Flexibility Tester for Organic Finishes" was developed by General Electric Co.'s Materials and Processes Lab.; will satisfactorily



INSTRUMENTATION ENGINEER

(Physicist or Electronics Engineer)

Once in a lifetime opportunity for physicist or electronics engineer with ability to design, construct and install setups used to obtain data on engine ignition and performance. Setups will be diversified so that projects might require mechanical and electronics instrumentation as required to best obtain information.

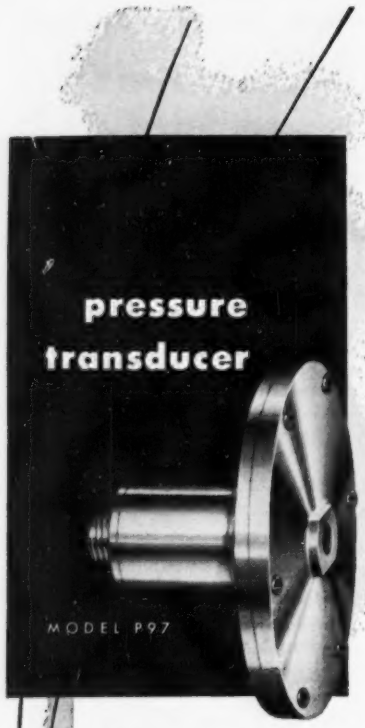
Also included will be design of auxiliary control circuits and writing of operation manual to be used by experimental department personnel.

ELECTRONICS ENGINEER OR PHYSICIST

If you have experience or ability in design, construction and evaluation of high voltage, high frequency circuits, we have an exceptional opportunity in which you will be interested.

Position requires applicant capable of designing circuits incorporating transistors, magnetic amplifiers and semi-conductors.

Interested applicants possessing necessary qualifications may apply for either of these excellent positions by writing to the Personnel Director, Electric Auto-Lite Company, Toledo 1, Ohio, outlining all pertinent data regarding responsibilities of present position, past experience, training and salary requirements.



Differential or gage pressures in the range 0-0.05 psi are measured accurately and simply with the Model P97 pressure transducer.

The output of this instrument is 3.5 millivolts per volt full scale, permitting direct operation of a wide variety of commercially available recording, indicating, or controlling devices.

Pressure applied to the instrument is translated into an exact electrical equivalent by means of a full bridge transducer based on the unbonded strain wire principle.

Please request Bulletin No. 3.5.

S&L Statham LABORATORIES • Los Angeles 64, Calif.

For more information circle **56** on inquiry card.

bend standard 1/16-in. steel panels; makes possible numerical rating of comparable materials.—*Gardner Lab., Inc., Bethesda* 14, *Md.*

For more information circle **276** on inquiry card.

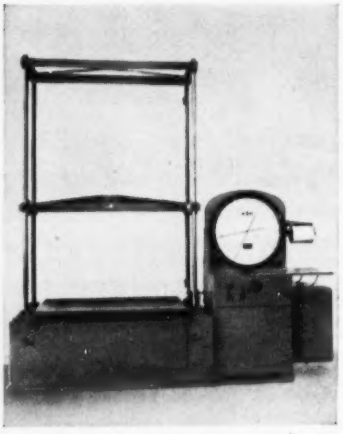
Pinhole & Void Detector for Paints, etc.

New "Model M-1" locates holidays (pin-holes, voids, etc.) in films of relatively high electrical resistance, applied to material of low electrical resistance. Non-destructive test will not injure good coated surface as might be done with a spark method. Exploring electrode consists of a sponge dampened with pure water and passed over surface to be inspected. A ground wire connects detector with low-resistance surface. Assembly is housed in a heavy leather case with provision for attachment to a belt.—*Tinker & Rasor, 203 Del Mar St., San Gabriel, Calif.*

For more information circle **277** on inquiry card.

Spring-assembly Tester

New 10,000 lb. spring testing machine for compression testing of complete spring assemblies, incorporates a mechanical recorder. Load is



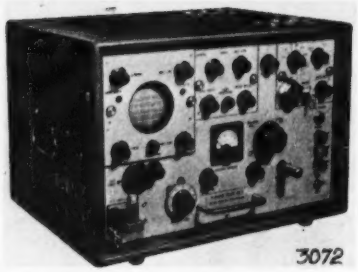
weighed by an equal set of levers (mounted directly under machine table) in combination with "Selecto-range" electronic indicating system. Even eccentric test loads can be weighed accurately. Test range can be changed during test, as all three ranges have same zero setting. Positive loading speeds infinitely-variable from 0.025 to 8 ipm. Clearance between screws 60 in.; standard columns take 72-in.-high compression specimen. —*Tinius Olsen Testing Machine Co., 1116 Easton Rd., Willow Grove, Pa.*

For more information circle **278** on inquiry card.

ELECTRICAL TESTING

Microwave Test Equipment

New easy-to-operate microwave testing instrument is designed to simplify laboratory and production-line testing as well as field testing and maintenance of X-band radar. Functions include means to measure power, observe transmitter spectral distribu-

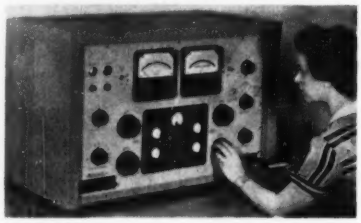


tion, measure frequency, supply artificial signals, analyze bandwidth characteristics; and square-wave generator aids in making standing wave measurements. Feature is modular construction, with each test section mounted on a separate plug-in subchassis. Special units can be provided which are interchangeable with standard sections.—*Kearfott Co., Inc., 14844 Oxnard St., Van Nuys, Calif.*

For more information circle **279** on inquiry card.

Calibration Equipment

New "Model 829 AC-DC Instrument Calibration Equipment" can be used for small lot production testing of electrical instruments, in general in-

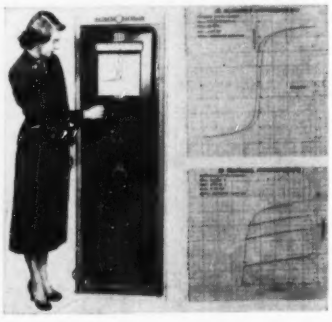


strument repair groups, and as a lab current and voltage standard; has 75 ranges. Frequency output on a-c. ranges is that of power source (most common source is 115 v. 60 cps.). Electrical interlocks protect against misoperation. Calibration charts show comparison of all ranges to basic standards with recent National Bureau of Standards calibration certificates.—*Radio Frequency Labs., Boonton* 13, *N. J.*

For more information circle **280** on inquiry card.

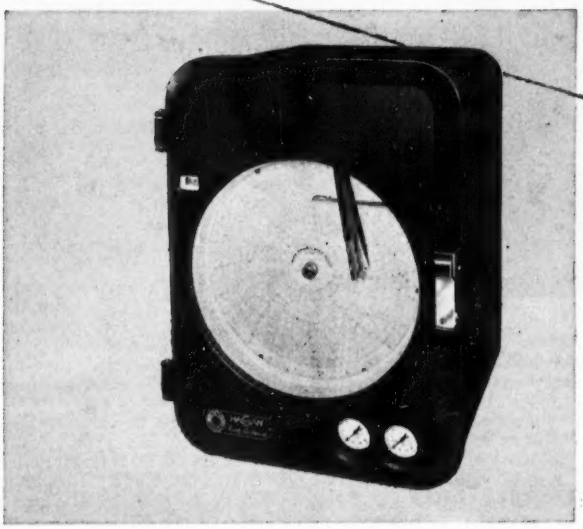
Hysteresigraph

New "D-C Recording Hysteresigraph" traces magnetic characteristics of a metal directly onto a scaled chart in a matter of minutes. Usual method requires long calculation, using data gathered from ballistic galvanometers. Hysteresigraph compiles



HAGAN

Ring Balance Meter *beats the high cost of* Permanent Pressure Loss!



It works out like this:

Using an Expensive Primary Element . . . 10% of 100″ full scale differential is *10″ PPL*

Using a Low Cost Primary Element . . . 50% of 6″ full scale differential is *only 3″ PPL*

The Hagan Ring Balance Meter is particularly adapted for accurate operation at full scale differentials as low as 1″ WC, with *any* type of primary element. In many applications, by choosing a low cost, low differential element, with a PPL of 50% or more, and measuring the flow with a Ring Balance Meter, the actual permanent pressure loss is low. In the example shown above, *it is only a third of the actual PPL* sustained with a high cost, high differential primary element. Here is positive, long range economy . . . lower pumping costs result from reduced horsepower requirement.

This is an example of how Hagan experience and engineering skill can reduce costs. Hagan engineers will be glad to recommend the most economical solution to your metering problem.

HAGAN HALL BUROMIN CALGON

HAGAN CORPORATION

HAGAN BUILDING PITTSBURGH 30, PENNSYLVANIA

Boiler Combustion Control Systems, Ring Balance Flow and Pressure Instruments . . . Metallurgical Furnace Control Systems . . . Control Systems for Automotive and Aeronautical Testing Facilities

For more information circle **57** on inquiry card.

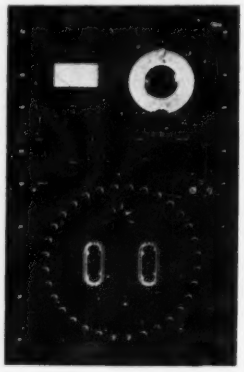
The Model TC-2 Temperature Test Chamber is a portable, self-contained, easy-to-operate unit ideal for laboratory and production line use.
Write for literature.
Temperature Range: —65°F to +350°F.
Holding Accuracy: ±2°F.
Coolant: Dry ice, 15 lbs. capacity.
Dry Ice Loading Port.
Heater: Electric Strip Heater.
Control: Thermostat, balancing heat against dry ice evaporation. Permanent Thermometer.
Test Lead Access: Removable tray, with 15 through ports.
Test Lead Capacity: 600 cubic inches.
Power Requirements: 115 volts, 5 amperes, 50-60 cycles, single phase.
STATHAM DEVELOPMENT CORPORATION
12411 W. Olympic Blvd., Los Angeles 64, Calif.
PRICE $550.00
F.O.B. LOS ANGELES
MODEL TC-2
PORTABLE TEMPERATURE TEST CHAMBER
FOR RAPID AMBIENT TEMPERATURE TESTS
For more information circle **58** on inquiry card.

and calculate these data with two fluxmeters which integrate flux voltage continuously. Will serve as quality-control instrument and also for obtaining data on commercially-available materials and in developing new alloys. Nine sensitivities (full-scale reading of 0-2000 interlinkages to 0-1,000,000 interlinkages) for materials ranging from ferrites to high-permeability nickel-iron alloys. Repetitive accuracy better than 0.5 percent. Hysteresis loops of tiny ring specimens can be drawn.—*General Electric Co., Schnectady 5, N. Y.*

For more information circle **281** on inquiry card.

Automatic Impedance Bridge

New automatic impedance bridge is used to test a specific multi-circuit electronic assembly; checks all circuits completely, including extraneous wiring. Among features: front panel selection of percentage limit tolerance. Unit illustrated accommodates 30 circuits.—*Cal-Tronics Corp.*, 11307 *Hindry Ave., Los Angeles 45, Calif.*



For more information circle **282** on inquiry card.

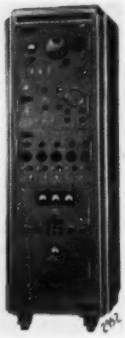
Temperature Switch Tester

New "Tempcal Tester" tests accuracy of aircraft thermal switches, separately or with their fire detection and anti-ice system. Feature: test is made at operating temperatures on aircraft. Cylinder head thermocouples and their circuits to flight deck instrument can also be checked.—*B & H Instrument Co., Inc., Fort Worth, Texas.*

For more information circle **283** on inquiry card.

Signal Generator

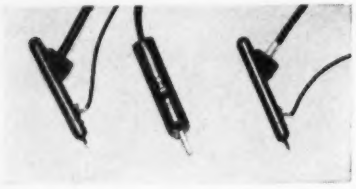
New "Model B Precision Multipulse Microwave Signal Generator" has been designed to check equipment requiring multiple pulse-modulated microwave frequency energy whose widths and delays can be accurately controlled. It comprises four interchangeable RF heads providing continuous coverage from 950 to 10,750 Mc. with single-dial direct-reading tuning controls. Direct-reading RF attenuator in each RF head. Modulator portion furnishes five pulse channels, each independently supplying pulse time modulation.—*Polarad Electronics Corp.*, 100 *Metropolitan Ave., Brooklyn 11, N. Y.*



For more information circle **284** on inquiry card.

CRO Test Probes

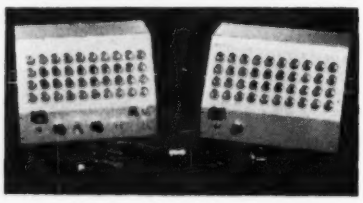
Three new test probes for use with general-purpose 'scopes: "Types 2607 and 2608" are small, lightweight probes of pistol-grip design, completely shielded against stray pickup; incorporate a unique tip which permits point-to-point circuit checks or which can be easily clipped to exposed circuit points for prolonged investigations. "Type 2609" detector test probe will operate over a carrier-frequency range of 250 kc. to 400 Mc. and has a response flat within 1 db over any 6-Mc. band in this range.—*Allen B. Du Mont Labs., Inc.*, 760 *Bloomfield Ave., Clifton, N. J.*



For more information circle **285** on inquiry card.

Automatic Cable Checker

New "Model 203" portable automatic cable checker comprises "Master" unit and "Slave" unit; can be operated by anyone without special training; affords quick and positive identification of conductor connections in terminated and unterminated cables. Master and Slave units each have forty numerically or alphabetically labelled indicator lamps on their front panels. One light identifies connector under test; two or more lights on slave unit are illuminated whenever a short is found. Checker is capable of scanning 40 contacts in eight seconds. By using any common metallic return (such as a ship's hull)



It gets its fuel through 1/4" tubing at pressures up to 1,700 psi

Meet the "Boss of the Crawlers"—Caterpillar Tractor Co.'s new 150 D.B. hp giant that toys with tons of earth, plays marbles with huge boulders, topples trees like tenpins.

Superior Tube supplies metal gullets through which such landscape levelers gulp their fuel.

Through ¼ inch O.D. tubing, diesel fuel is injected to cylinders at pressures up to 1,700 psi. So fuel injection tubing must be clean, have tremendous burst strength and resistance to fatigue. To meet Caterpillar's stringent specifications, Superior selects C-1008 Low Carbon Steel Tubing, draws it to size 250/255" O.D. x 0575/0675" I.D., then tests its mechanical properties to the utmost.

Result: heavy wall tubing with Rockwell hardness of B-65 maximum—capable of being cold upset without difficulty and cold formed into loops and bends without excessive springback. Bore is of uniform diameter, smooth and specially cleaned, and fracture testing and inspection at 15 power magnification assure freedom from cracks or seams of a depth greater than 5/1000 of an inch!

Scrupulous care in preparing, drawing and testing other grades of alloy and stainless Superior tubing makes them first choice for lubricating and cooling lines, governor shafts, valve spacers and valve push rods. One of our more than 55 analyses should be *your* choice, too, if you need trustworthy tubing and special help in adapting it to your use. Write us about your current tubing problem. We'll send you complete information and the appropriate catalog or technical bulletin by return mail. Superior Tube Company, 1968 Germantown Ave., Norristown, Pa.

Round and Shaped Tubing Available in Carbon, Alloy and Stainless Steels; Nickel and Nickel Alloys; Beryllium Copper; Titanium; Zirconium.

All analyses .010" to ⅜" O.D. Certain analyses in light walls up to 2½" O.D.

Superior Tube

The big name in small tubing

West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif. RAymond 3-1331

For more information circle **59** on inquiry card.

MAINTAIN ACCURACY

high temperature ACCELEROMETER

Now, Pacific Scientific presents a unique new *high temperature* accelerometer, designed by Humphrey to give accurate, clear signals at temperatures from −65° to +550° F. — far in excess of former operating ranges! The rugged stainless steel and ceramic construction provides long life and allows precision tolerances for maintaining repeatability.

For the higher temperatures encountered in missile work, as well as for use in all types of aircraft where heat dissipation is a problem, this new unit provides the ideal answer!

SPECIFICATION DATA:

- **Environmental**—Temperature: −65° to +550° F. Shock: 60 G's in any direction without damage to the instrument.
- **Accuracy**—Within ½% to 2% depending upon G range and potentiometer resistance. (Including linearity, resolution and environmental conditions.)
- **Range**—Any range from −1 G +1 G and −50 G +50 G. Also available in asymmetrical ranges.
- **Resolution**—0.4% to 0.2% of full range. Potentiometer resistance can be furnished with any DC value between 300 and 20,000 ohms for all ranges.

PACIFIC SCIENTIFIC—pioneering the field of aircraft instrumentation since 1919

Write for full details and specifications—*today!*

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LOS ANGELES, CALIF., 1430 Grande Vista Ave.
SAN FRANCISCO, CALIF., 25 Stillman Street
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ARLINGTON, TEXAS, 111 East Main Street

For more information circle **60** on inquiry card.

NEW INSTRUMENTS

cables terminated at widely separated points are automatically checked. Also checks cables with connectors on both ends or with connectors on one end, and with lug terminations or terminal strips on other end. Handy mercury pool eliminates stripping unterminated cables. Operates on 117 v.ac. supply.—*Link Aviation, Inc., Hillcrest, Binghamton, N. Y.*

For more information circle **286** on inquiry card.

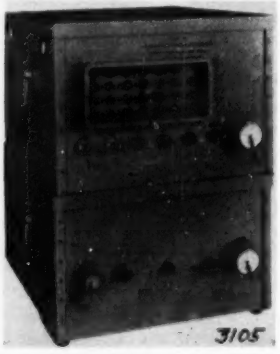
Time-base Calibrator

New "Type 300" is a portable crystal-controlled time calibrator designed to check instruments that employ time bases or incorporate timing functions. A 10-Mc. sine-wave, and five sharply-peaked pulse outputs having repetition rates variable in decade steps from 1 usec. to 10 millisec., are provided. Accuracy at any repetition rate is within 0.1 percent. Either 3-volt positive or 30-volt negative pulse outputs may be selected. Synchronizing signals of 100 cps. and 1, 10, and 100 kc. rates permit accurate triggering of CRO's or other devices at desired rates regardless of timing pulse-rate selected. "Type 300" serves also as a shaper for external signals, transforming them into sharp pulses at same frequency.—*Instrument Div., Allen B. DuMont Labs., Clifton, N. J.*

For more information circle **287** on inquiry card.

Split-microsecond Timer

New "Model 471X Counter Chronograph," for testing radar and sonar equipment under field (or shipboard) conditions, contains a temperature-

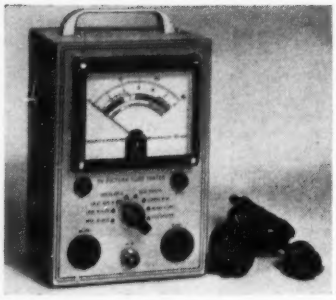


compensated crystal-controlled 8-Mc. oscillator that produces timing pulses exactly ⅛ usec. apart. Neon lamps give direct indication of exact number of microseconds and eighths contained in measured interval. Results may be observed visually or applied to a recorder or printer (also available from maker). Lockout arrangement prevents pulses other than those intended for starting and stopping from affecting instrument, thus making it possible to time intervals between two pulses occuring in a repetitive train.—*Potter Instrument Co., Inc., 115 Cutter Mill Rd., Great Neck, L. I., N. Y.*

For more information circle **288** on inquiry card.

Picture Tube Tester

New "Model 701" picture tube and TV receiver tester dynamically tests all magnetically deflected black-and-



white or color tubes under actual receiving conditions.—*Boland & Boyce, Inc., 236 Washington Ave., Belleville 9, N. J.*

For more information circle **289** on inquiry card.

TV-components Tester

New "Model 100 6-in-1" tests flyback transformers and yokes and will detect one shorted run; tests picture tubes in or out of set for emission, shorts or electrical leakage; is a selenium rectifier checker; is a picture tube reactivator; checks capacitors for capacity, shorts or open; checks continuity.—*Transvision, Div., of Sightmaster Corp., New Rochelle, N. Y.*

For more information circle **290** on inquiry card.

ELECTRICAL INSTRUMENTS

Electrical Indicating Instruments

New sealed ruggedized panel instruments are available in d-c. ranges showing any practical scale from 300 microamperes to 800 milliamperes, in 2½-in. and 3-½-in. sizes. Introduction of these new panel instruments does not affect maker's other manufacturing commitments.—*Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill.*

For more information circle **291** on inquiry card.

Electrical Indicating Instrument

New "Model #23" features 4⅝ x 4-3/16-in. clear styrene plastic case for easier reading and more information on the dial. New style case is molded in such a manner that each

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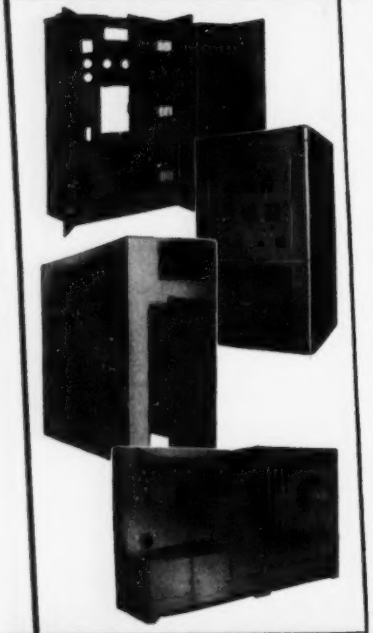

Manufacturers of Electrical and Hydraulic Control equipment must have accuracy in the fabrication of Cubicles, Cabinets, Control Boards and Panel Boards. Accuracy comes through experience in knowing how to shear, bend, form and weld plate and sheet metals. Littleford has that experience, plus skilled craftsmen, as industry has been served by Littleford since 1882.

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For more information circle **61** on inquiry card.

NEW INSTRUMENTS

customer may individualize lower portion of clear front with his own design.—*Beede Electrical Instrument Sales Corp., Penacook, N. H.*

For more information circle **292** on inquiry card.

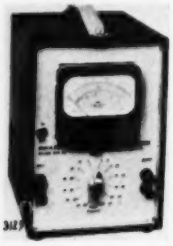
Electrical Indicating Instruments

New electrical indicating instruments conform to ASA and government JAN-1-6 specs; include dc.

microammeters, milliammeters, voltmeters and ammeters in a variety of ranges, resistance values and sensitivity; in 2½ and 3½-in. round or square cases, plus 4-in. rectangular models.—*Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.*

For more information circle **293** on inquiry card.

VTVM

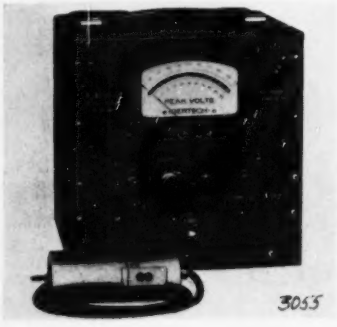


New "Model 202" features wide frequency range (20 cps. to 2 Mc.) and full-scale ranges from 0.001 to 300 volts in twelve steps. Input impedance 10 megohms shunted by 15 mmf (4mmf on lower ranges). Separate terminals are brought out from input and output of amplifier section, permitting use as a separate amplifier with maximum gain of 50 db. —*Shasta Div., Beckman Instruments, Inc., P. O. Box 296, Sta. A, Richmond, Calif.*

For more information circle **294** on inquiry card.

Peak-to-peak VTVM

New "Model VM-1" is a true peak-reading vacuum-tube voltmeter designed to operate over a wide bandwidth (50 cps. to over 100 Mc.); may

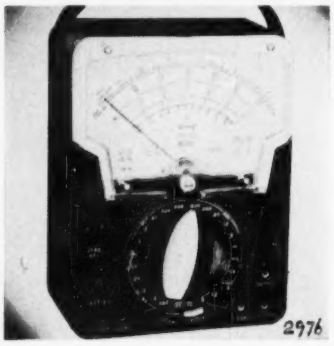


be used to measure positive peak, negative peak, or peak-to-peak voltage of a waveform. Voltage range is 100 v. full-scale, with multipliers to 30 kv.; rapid selection of voltage ranges. Detector and amplifier circuits and components are such that back resistance of diode detector is greater than 10^{12} ohms, giving an exceptionally long discharge time constant to whole circuit. All critical voltages, including electrometer tube filament and diode filaments, are regulated.—*Gertsch Products Inc., 11846 Mississippi Ave., Los Angeles 25, Calif.*

For more information circle **295** on inquiry card.

Combination V-O-M VTVM

New "Model 631" combines a volt-ohm-milliammeter and a vacuum-tube voltmeter; has 34 ranges. Sensitivity: V-O-M: 20,000 ohms per volt on d.c.;

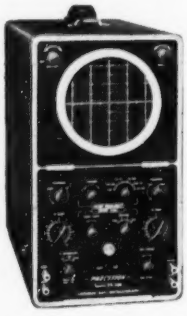


500 ohms per volt on a.c. VTVM: 11 megohms. One switch selects all ranges and minimizes chance of incorrect settings and burnouts. Top scale arc length 4.588 in. VTVM stability is assured by battery operation. Quick measurements are possible at all times in any situation. Batteries easily replaced; may be checked without opening case.—*Triplett Electrical Instrument Co., Bluffton, Ohio.*

For more information circle **296** on inquiry card.

Five-inch Oscilloscope

New "Model ES-520" 5-in. CRO is announced as "a factory-engineered, factory-wired and factory-calibrated instrument that provides basic oscillography at a price within reach of all



to whom initial investment is of extreme importance." Push-pull vertical and horizontal drive; 20 mv./in. vertical sensitivity; 50 mv./in. horizontal sensitivity; 3-step frequency-compensated vertical input attenuator; vertical frequency response 20 cps. to 500

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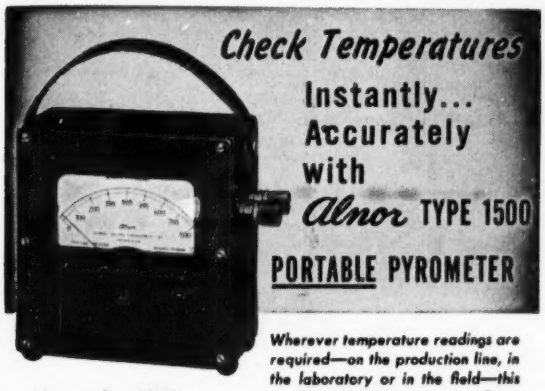
For more information circle 62 on inquiry card.



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For more information circle 63 on inquiry card.

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Available in standard dials (reading in inches of water) 0-15" -0-30" -0-60" -0-100" -0-160" . . . also in ounce graduated dials from 15 ounces to 5 pounds. 2½", 3½" and 4½" dial sizes mounted in black enameled steel case.

Marshalltown Figure 83 is an extremely sensitive gauge that uses a carefully seasoned bronze diaphragm to accurately measure very low pressures. It is used extensively on many types of natural gas installations for checking low pressures.

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A

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Enhanced appearance: The glow of light and sparkle of a lens add colorful visual attraction.

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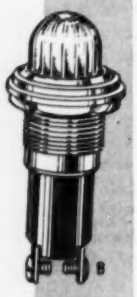
Added service: Discs inserted behind lenses can be used to deliver specific messages, such as "FUEL LOW", "ON", "OFF", etc.


B

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Dialco offers the *complete* line of pilot lights, from sub-miniature types to giant units with 1½" lenses.

Every assembly is available complete with lamp.

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Illustrations are approx. 70% actual size . . . *(A)* No. 8-1930-111 sub-miniature pilot light . . . *(B)* No. 521308-991, with multivue cap . . . *(C)* No. 922210-111, dimmer type . . . *(D)* No. 47901 with light shield cap.

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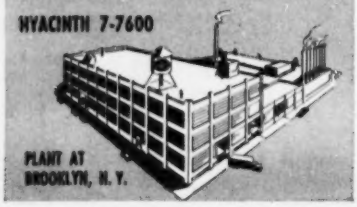


For more information circle **65** on inquiry card.

NEW INSTRUMENTS

kc. within 2 db and to 200 kc. within 3 db (at full gain); 1 volt, peak-to-peak, built-in vertical voltage calibrator. New low-price model does not replace "Model ES-500A" which incorporates many features for more advanced applications.—*Precision Apparatus Co., Inc., 92-27 Horace Harding Blvd., Elmhurst 6, Long Island, N. Y.*

For more information circle **297** on inquiry card.

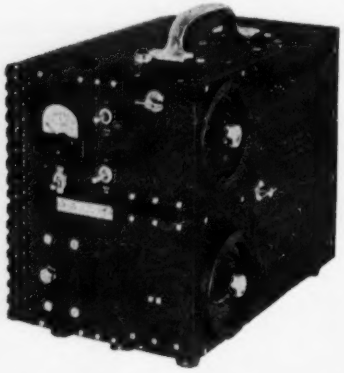
Noise-figure Meter

New "Rada-Node" provides accuracy to 0.25 db in measuring noise figure. It includes IF and microwave noise sources, 30- and 60-Mc. amplifiers, calibrated attenuators, and indicator. Noise source has a frequency range with noise diode "A" of 5 to 400 Mc., with noise diode "B" of 100 to 3000 Mc., and with gas tubes of 1200 to 26,500 Mc. in eight bands depending on wave-guide size. Noise figure range 0 to 21 db. Amplifier gain 75 db; amplifier bandwidth 14 Mc. Input impedance 50 ohms.—*Kay Electric Co., Pine Brook, N. J.*

For more information circle **298** on inquiry card.

Six-channel Oscillograph

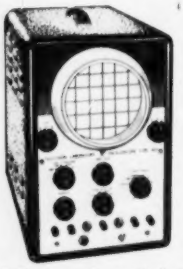
New version of maker's "Model 401-6 Portable Recording Oscillograph" has a small lightweight rectifier unit to replace detachable 8-v.



battery case, permitting operation from 115-v. 50-400-cps. power as well as from an 8-v.dc. internal or external source. Conversion is made in minutes.—*Heiland Research Corp., 130 E. 5th Ave., Denver 9, Colo.*

For more information circle **299** on inquiry card.

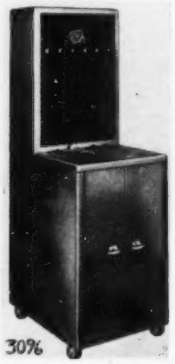
TV-lab CRO



New "Model 404" 7-inch oscilloscope is said to be an exceptionally high-gain wideband instrument created especially for designing and servicing TV receivers. Vertical sensitivity 10 mv./in.; vertical response flat from 10 cps. to 2 Mc. and useful to 4 Mc.; faithful square wave response to 500 kc. Low internal hum level; input impedance 5.0 megohms and 26 uufd for negligible circuit loading; internal hard-tube multivibrator sweep circuit; linear sweeps from 25 cps to 50 kc. usable to 130 kc.; rapid return trace; control for synchronizing to either positive or negative signals; wide-range phasing control, and internal 60-cps. sine wave sweep which eliminates one set of leads during alignment operations.—*Sylvania Electric Products Inc., 1221 W. Third St., Williamsport, Pa.*

For more information circle **300** on inquiry card.

High-speed Oscillograph



New "Type M Dynograph Recorder" high-speed direct-writing oscillograph is said to provide exceptionally high, absolutely stable d-c. or a-c. amplification. It may be used with reluctance type pickups without auxiliary equipment: no need for usual additional amplifiers or pre-amplifiers. Exceptionally high sensitivity: 150 microvolts d-c. per centimeter of pen deflection. Non-drifting. Pen response 1/120 sec. Over 8 cm. of pen excursion available with linearity of 1 percent up to 4 cm. Instrument features individual plug-in amplifiers and, by means of input panels, provides all requisite connections for a variety of signal pickups.—*Offner Electronics Inc., 5320 N. Kedzie Ave., Chicago 25, Ill.*

For more information circle **301** on inquiry card.

Audio Generator

New "Type 1304-B Beat-Frequency Audio Generator" features an extended frequency range (20-40,000 cps.), an improved amplifier and addition of

an output attenuator and voltmeter. Frequency dial, with logarithmic calibration, can be coupled directly to recorder. Synchronous motor dial drives are also available. Output amplifier uses new single-ended push-pull circuit and supplies one watt into a 600-ohm load with less than 0.25 percent distortion between 100 and 10,000 cps. —*General Radio Co., Cambridge 39, Mass.*

For more information circle **302** on inquiry card.

"C" Band Wavemaster

New "Model 230" is a coaxial-line type instrument, covering frequency range from 3500 to 6500 Mc. by either transmission or absorption method. Among features: (1) precision-ground lead screw; (2) a cavity body precision-machined from a solid block; (3) use of Invar in line displacement por-

Instruments to • MEASURE • RECORD • CONTROL Light

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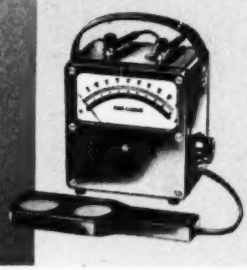
For quick measurements in homes, factories, etc. Calibrated in seeing tasks (Sightmeter) and directly in foot-candles. Available with or without VISCOR® and cosine correction filters.

Model 614 Foot-Candle Meter

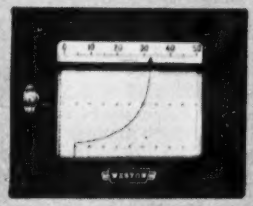
For commercial lighting surveys. Hinge mounted PHOTRONIC® Cell can be tilted to facilitate use. Measures all types of commercial lighting directly. Wide range of light values.

Model 756 Illumination Meter



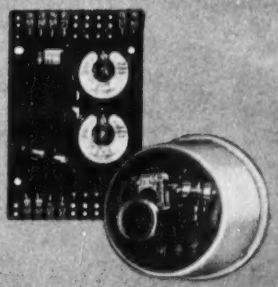
For measurements requiring a high degree of accuracy over broad ranges. Ideal for research and checking other instruments. Corrected for color and Lambert's Cosine Law.

WESTON LIGHT RECORDER



Fluctuations in illumination are accurately charted by the Model 6701 WESTON Light Recorder. PHOTRONIC® photo-electric cell sensing element can be placed wherever convenient. Recorders available with ranges from 20 ft. candles up to as high as 15,000 ft. candles. Ideal for load anticipation studies, determining light output of flares, daylight measurements, and many other industrial applications.

WESTON LIGHT CONTROLS



The Model 1089 plug-in type is the simplest control unit for automatically turning lights "on" and "off" at pre-set levels. Employs no vacuum tubes, resistors or capacitors. Controls either one or two circuits of 3000 watts each at 120 volts a-c. In standard weatherproof watt-hour meter case. The Model 709 (CAA approved) permits quick adjustment of "on" and "off" light values independently, in the field.

For complete information on these WESTON instruments write . . .
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PALMER

THERMOMETERS, INC.

Norwood Ave., Cincinnati 12, Ohio

Mfrs. of Industrial Laboratory Recording and Dial Thermometers

For more information circle **67** on inquiry card.

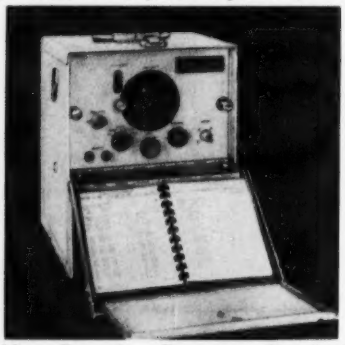
NEW INSTRUMENTS

tion for frequency stability; (4) triplating of all RF surfaces. Approximate loaded Q is 2500.—*Amerac, Inc., 116 Topsfield Road, Wenham, Mass.*

For more information circle **303** on inquiry card.

Frequency Meter

New "TS 175 A/U" covers 85-1000-Mc. range; calibration accuracy 0.005 percent; stability 0.0025 percent; suit-

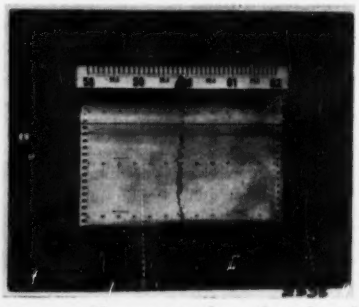


able as Secondary Frequency Standard having 5000 kc. crystal; internal 1-kc. modulator for visual presentation on UHF or VHF TV channels.—*Colortone Electronics, Inc., 238 William St., New York, N. Y.*

For more information circle **304** on inquiry card.

Frequency Recorder

New frequency recorder is said to incorporate faster response, increased accuracy and extension of linearity

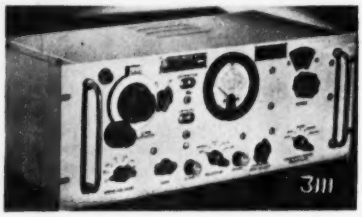


over a wider range than that found in conventional instruments. Accuracy 0.01 cps.; sensitivity 0.005 cps.; unaffected by changes in ambient temperature or wave-form; available with 12- and 24-second pen speeds; for 50- or 60-cps. service.—*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.*

For more information circle **305** on inquiry card.

Crystal Impedance Meter

New "Model 541-A (TS-710/TSM)" measures effective resonance and antiresonance of quartz crystal units; is

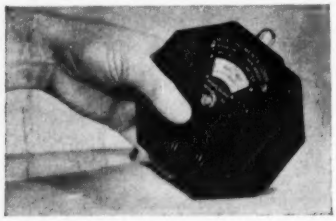


suitable for use as a reference standard in quartz crystal industry; replaces "Model 460 (TS-537/TSM)"; comprises a two-tube resistance-capacitance coupled oscillator covering a frequency range of 10 to 1100 kc. in five bands.—*Radio Frequency Laboratories, Inc., Boonton 13, N. J.*

For more information circle **306** on inquiry card.

UHF Grid-dip Oscillator

New "Model 59 UHF Megacycle Meter" covers 430-940-Mc. range, is especially designed for new TV fre-

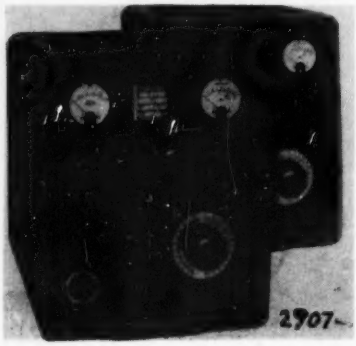


quency band, Citizen's radio band and important mobile communication bands. Case is functionally designed for easy positioning, has standard camera socket for tripod mounting. Instrument is rated at 30 watts and operates from standard 117-v.ac. source.—*Measurements Corporation, Boonton, N. J.*

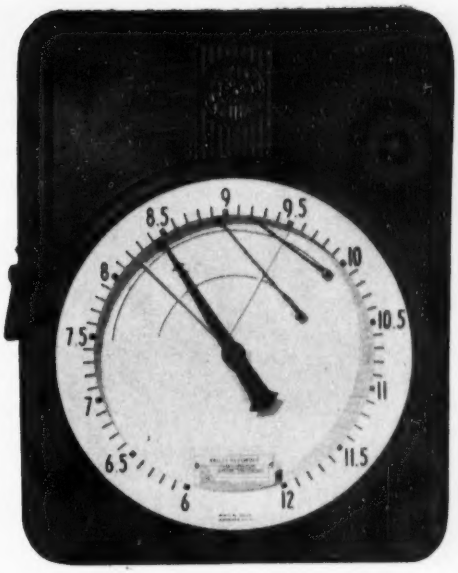
For more information circle **307** on inquiry card.

VHF Signal Generators

New "Model 608D" VHF signal generator offers low residual FM, drift less than 0.005 percent, sensitivity measurements to 0.1 microvolt and "a new high in stability." It covers 10-420-Mc. range. Built-in crystal calibrator provides frequency check accurate within a few kc. every 5 Mc. through range. ★ "Model 608C" general-purpose instrument provides



PYROTRON
by BAILEY...



Your best buy for Precision Temperature Measurements In the -300F to 1200F Range

Check These Exclusive Bailey Advantages of Resistance Thermometer Operation

✓ Resistance thermometer operation over a complete range from —300F to 1200F has been made possible by Bailey's development of a low-cost platinum resistance element.

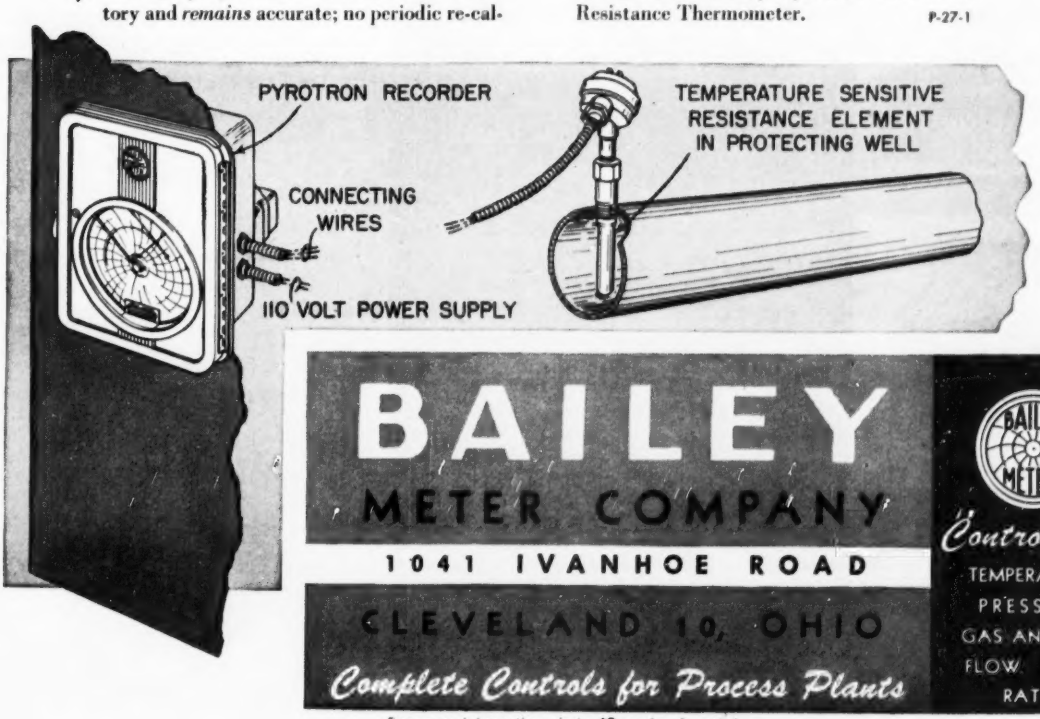
✓ Resistance thermometer operation requires no standard cell, dry battery and cold junction compensator. Uses 115 volt a-c source. Strong signal and high precision of resistance element as compared to thermocouple makes possible the use of narrow range spans.

✓ The Bailey Pyrotron is calibrated at the factory and *remains* accurate; no periodic re-calibrations required. Since all elements are matched it is not necessary to calibrate each recorder to its element.

✓ Recorder is sensitive to 1/10 of 1% of range span.

✓ Ordinary copper lead wires permit remote location of recorder with respect to the temperature sensing element.

✓ For complete information, write for bulletin 230-C on the Bailey Pyrotron Electronic Resistance Thermometer. P-27-1



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For more information circle **68** on inquiry card.

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BASIC PT6 MAGNECORDER
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MBD MAGNECORDER
Magnecorders are the most widely used professional tape recorders in the world! These versatile, dependable units are ideally adapted for research, testing, data recording, and many other uses — delivering the highest performance characteristics available at any price level. The proof — and the truth—is on every Magnecord tape.
Magnecord dealers are listed under "Recorders" in your classified telephone directory.
magnecord, inc.
1101 SOUTH KILBOURN AVENUE
CHICAGO 24, ILLINOIS
DEPARTMENT IA-10
For more information circle **69** on inquiry card.

NEW INSTRUMENTS

1 volt output and frequency coverage of 10 to 480 Mc., measures gain, sensitivity, selectivity and image rejection of VHF equipment; or drives bridges, slotted lines, etc.—*Dept. P, Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.*

For more information circle **308** on inquiry card.

ELECTRICAL-INSTRUMENT ACCESSORIES

A-c. Decade Box

New "Dekabox" provides more than a million 1-ohm resistance steps from zero to 1,199,999 ohms. Adjustable

mounting base may be set to most convenient angle. Six decade dials display value of resistance in a single horizontal line. Resistors adjusted to within 0.05 percent of rated value; special windings minimize frequency error; negligible temperature coefficient.—*Electro Measurements, Inc., 4312 S. E. Stark St., Portland 15, Oregon.*

For more information circle **309** on inquiry card.

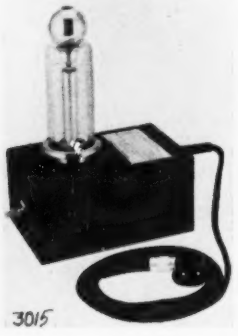
Resistance and Capacitance Decades

New panel-mounted resistance decades and capacitance decades are designed for use by laboratories, or manufacturers, building their own test equipment. Of standard RETMA relay rack dimensions, they are identical electrically to maker's standard cabinet decades.—*Industrial Instruments, Inc., 89 Commerce Rd., Cedar Grove, N. J.*

For more information circle **310** on inquiry card.

HV Multiplier

New "Model 620 Extra-High-Voltage Multiplier" allows measurement of alternating potentials up to 60 kv. peak with all maker's (and other)



voltmeters and serves as a potential divider with most CRO's. Voltage is attenuated 10,000 to 1 with an accuracy of 2 percent between 60 cps. and 6 Mc.—*Ballantine Labs., Boonton, N. J.*

For more information circle **311** on inquiry card.

Electronic Switch

New "Model 488 Electronic Switch" permits simultaneous observation of two traces on 'scope screen; also serves as a square-wave generator over range of switching frequencies. Continuously variable switching rates (and square-wave frequencies) in 3 ranges from less than 10 cps. to over 2000 cps.—*Electronic Instrument Co., Inc., 84 Withers St., Brooklyn 11, N. Y.*

For more information circle **312** on inquiry card.

WWV Receiver

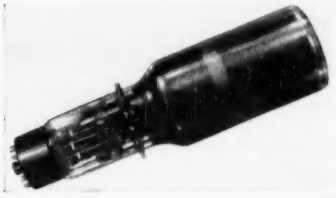
New "Model 1201" is constructed expressly to receive radio stations WWV and WWVH, time and frequency standard stations of National

Bureau of Standards. Circuit features dual conversion and narrow-band IF stages for maximum selectivity and image rejection. Four IF stages insure adequate sensitivity for good reception under most difficult conditions.—*Shasta Div., Beckman Instruments, Inc., P. O. Box 296, Station A, Richmond, Calif.*

For more information circle **313** on inquiry card.

Three-gun CR Tube

New "Type 53RAP" is said to be "electronic industry's first 3-gun cath-

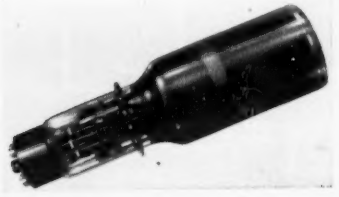


ode-ray tube, comparable in quality to the finest of 2-gun tubes."—*Electronic Tube Corp., 1200 E. Mermaid Lane, Philadelphia 18, Pa.*

For more information circle **314** on inquiry card.

Six-gun CR Tube

New cathode-ray tube displays up to six independent or related phenomena simultaneously on its 7-in. diam. face; uses electrostatic focus and deflection, with adequate shielding



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FIXED WIREWOUND POWER RESISTORS

OUTPERFORMS ALL CONVENTIONAL POWER RESISTORS

- Higher Wattage Ratings — smaller sizes
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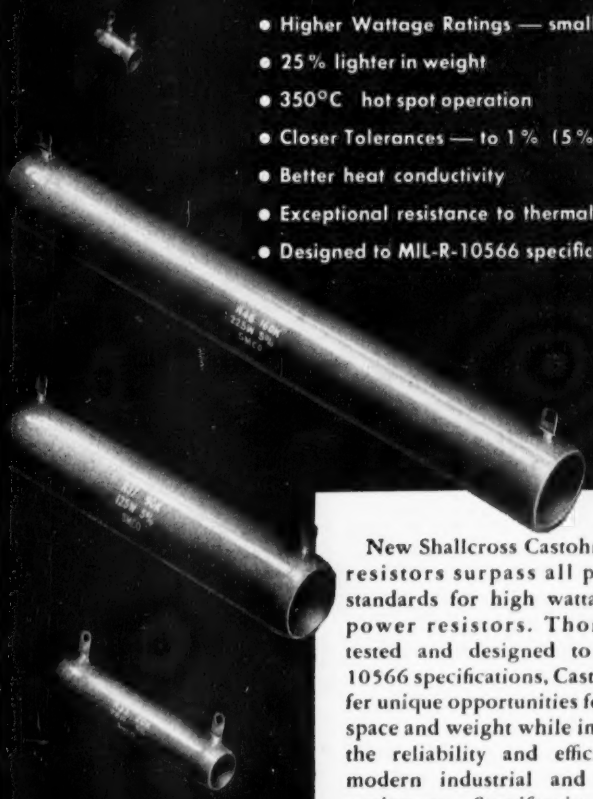
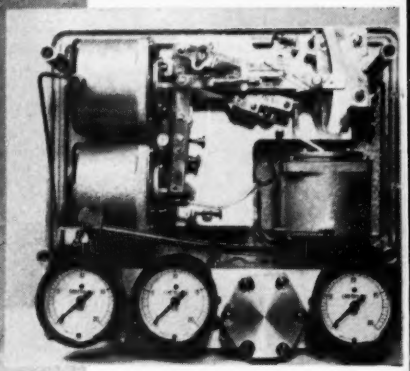
- 350°C hot spot operation
- Closer Tolerances — to 1% (5% standard)
- Better heat conductivity
- Exceptional resistance to thermal shock
- Designed to MIL-R-10566 specifications



New Shallcross Castohm power resistors surpass all previous standards for high wattage fixed power resistors. Thoroughly tested and designed to MIL-R-10566 specifications, Castohms offer unique opportunities for saving space and weight while improving the reliability and efficiency of modern industrial and military equipment. Specifications on all types from 8 to 225 watts are yours for the asking. SHALLCROSS MANUFACTURING COMPANY, 510 Pusey Ave., Collingdale, Pa.

Shallcross

For more information circle **70** on inquiry card.



Interior view of Ratio Relay shows simple, compact construction. Pressure gages indicate input signals and output pressure. Adjustments for control action, zero setting and ratio range are readily accessible.

The Tel-O-Set Ratio Relay offers these unique features:

★ **LINEAR RATIO**

Output changes in straight-line relation with primary variable. Permits better control tuning . . . eliminates "compromise" settings.

★ **DIRECT OR REVERSE ACTION**

Readily set to provide either increasing or decreasing output . . . increasing or decreasing ratio.

★ **FLEXIBLE ADJUSTMENT**

Ratio range can be reduced to any desired value. Reduced span can be positioned at any desired portion of the maximum range. Factory setting is 50—150% ratio range.

★ **WIDE RANGE**

Ratio can vary from 0 to 200% for a full scale change in the primary variable.

★ **ADJUSTABLE LIMITS**

Readily set stops are provided to limit minimum and maximum output pressure.

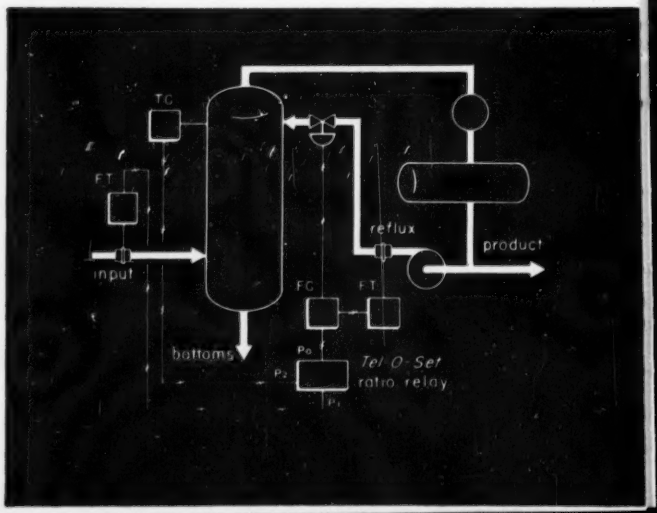
★ **ZERO SUPPRESSION**

Independent zero adjustments permit selection of the exact input-output relationship desired.

★ **INDICATING GAGES**

Separate indicators show output pressure and both input pressures.

On a distillation column, Tel-O-Set Ratio Relay receives air signal (P_2) from column temperature controller. This signal varies the ratio of the output pressure (P_0) to the signal received (P_1) from the input flow transmitter. Output pressure feeds into an *Indexet* remote setting index in the flow controller, to reset this instrument and thus throttle the valve in the reflux line. Ratio of reflux to input is thus varied in accordance with temperature of the top of the column.



New, versatile means for effecting cascade control

the Tel-O-Set Ratio Relay

HAVE a complex control loop? Here's a versatile way to simplify it . . . the new *Tel-O-Set* Ratio Relay. Another advanced idea in process control from Honeywell, this unique relay proves the ideal solution to complex cascade control problems.

The Ratio Relay provides automatic control with a single element influenced by three interrelated variables. For example, it is used on distillation columns (see diagram) to control the ratio of reflux to feed, as column temperature varies. In absorption towers, it regulates ratio of absorbent and feed stock to give constant concentration of product. And there are scores of other uses for this relay . . . in evaporators, controlled-atmosphere furnaces, reaction tanks, engine testing and other applications where several related variables must be interlocked for efficient operation.

The Ratio Relay receives pneumatic signals from remote transmitters, controllers or manual loading stations. It produces an output air signal for readjusting the set point of a secondary controller. It is the ideal companion for Honeywell Differential Converters, *Tel-O-Set* miniature instruments and Brown pneumatic controllers.

Your nearby Honeywell sales engineer will be glad to discuss applications to your specific process . . . and he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA: Write for Bulletin 8410, "*Tel-O-Set* Ratio Relay."**

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

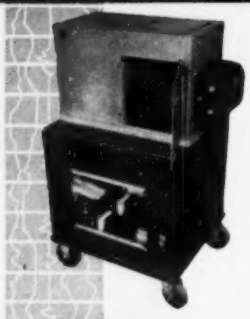
For more information circle **71** on inquiry card.

No more worries about
FREQUENCY RESPONSE
or
WRITING SPEED.

The NEW and PHENOMENAL

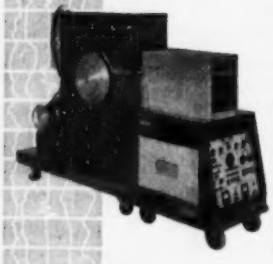
HATHAWAY Type SC-16
OSCILLOGRAPH

with 6 elements is *flat from 0 to 200,000 cycles per second*, and its traces have a writing speed of *5 million inches per second.*



Fast transients and high-frequency phenomena now can be accurately recorded.

Several types of continuous-drive record magazines are available for 6-inch sensitized paper and film, and for 35-mm film. The magazine shown on the oscillograph at the left accommodates 100-foot rolls of record paper.



Drum-type magazines, both small and large, are valuable for short high-speed records. The large drum-type magazine at the left has a drum 3 feet in diameter and 6-inches wide. It can be driven at 3000 RPM for a *chart speed of 6000 inches per second* when high resolution is needed. It can be used to take one 10-foot record or a larger number of shorter records.

The ASC-10 6-element direct-coupled amplifier will drive the SC-16 oscillograph from potentials of millivolt level.

Useful for strain recording to 100 Kilocycles.

AUTOMATIC OPERATION Initiate a transient with the oscillograph, or let the transient start the oscillograph.

QUICK-CHANGE TRANSMISSION for wide range of record speeds.

PRECISION TIME LINES.

Z-AXIS MODULATION for timing to one-tenth millisecond.

QUICKLY-INTERCHANGEABLE LENS STAGES for different record and trace widths.

Write for Bulletin 2G1-L for details.

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For more information circle **72** on inquiry card.

against crosstalk. Each gun can be controlled independently, and scans all of useful screen area. When tube is operated at accelerating voltages of 2 and 4 kv, horizontal and vertical sensitivities are about equal. Choice of phosphors.—*Electronic Tube Corp., 1200 E. Mermaid Lane, Philadelphia 18, Pa.*

For more information circle **315** on inquiry card.

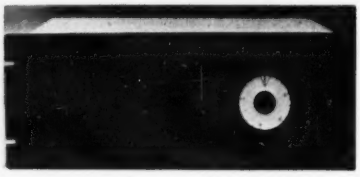
Oscillograph Magazine

New 250-ft. magazine extends application possibilities of maker's "Model 580 Oscillograph." It holds 250 ft. of 3⅝-in. wide Kodak Linagraph 809 Spec. No. 1 or 375 ft. of DuPont Type W industrial recording paper. It will operate at any standard speed (½ to 44¾ in./sec.) for which "Model 580" is designed while subjected to ± 7 *G* along any axis.—*Midwestern Geophysical Lab., 3401 S. Harvard, Tulsa, Okla.*

For more information circle **316** on inquiry card.

Line-voltage Regulator

New "Type 1570-A Automatic Voltage Regulator" has 6-kva capacity, 0.25 percent accuracy, 98-percent efficiency, excellent transient response, and no power-factor restrictions or



wave-form distortion. It comprises a "Variac" autotransformer that adjusts output voltage, a buck-or-boost step-down transformer that multiplies power rating of "Variac," and a servomechanism that positions "Variac." A proportional-control servomechanism, rather than usual on-off type, is used to provide better accuracy and transient response.—*General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.*

For more information circle **317** on inquiry card.

Calorimetric Wattmeter Terminations

New "Model MC-1B" with associated adapters covers range from 2600 to 26,500 Mc. "MCX-1A," a coaxial type, 100 to 3000 Mc. "MCL-1A" L-

Band termination (shown), with adapters, 1120 to 2600 Mc. All models feature Primary Standard accuracy and direct reading of average power up to 600 watts, over a plurality of expanded scales. Terminations are supplied with an associated liquid circulator which can be modified, on request, to permit metering of high average powers.—*Cubic Corp., 2841 Canon St., San Diego 6, Calif.*

For more information circle **318** on inquiry card.

Oscilloscope Calibrator

New oscilloscope calibrator, for measuring peak to peak voltages, employs comparative method where line voltage is calibrated and compared in amplitude to unknown waveform on 'scope. Two mounting bars are provided whereby calibrator can be permanently connected to 'scope. When calibrator is turned off, input is connected "straight through" and unknown waveform is applied directly to 'scope input.—*Service Instruments Co., 422 So. Dearborn St., Chicago, Ill.*

For more information circle **319** on inquiry card.

Minimum-noise Cable

New by-the-mile availability of "Mininoise Cable" is announced. Continuous-cable form permits greatly reduced cost.—*Microdot Div., Felts Corp., 1826 Fremont Ave., South Pasadena, Calif.*

For more information circle **320** on inquiry card.

AMPLIFIERS

Magnetic Amplifier

New "R6G10W1" small 60-cps. magnetic amplifier featuring 1-cycle response is said to be ideally suited, without need of a pre-amplifier, for medium-performance indicating or position type servomechanisms (and, with a simple pre-amplifier, in the most accurate and demanding control systems). It delivers 10 watts reversible phase output for reversible phase a-c. or reversible polarity d-c. input. Minimal number of components assures long service life.—*Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y.*

For more information circle **321** on inquiry card.

Magnetic Amplifiers

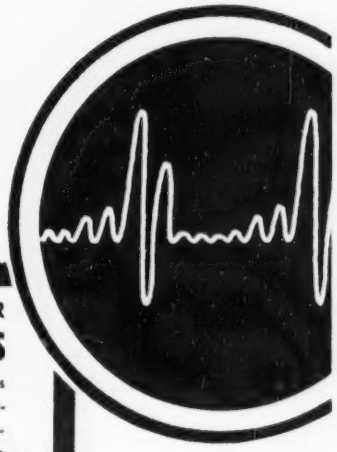
New series of magnetic amplifiers is for servomotor applications. "Types MAT-1, MAT-2, MAT-3, and MAT-4" will respectively handle 2-, 4-, 6-, or

9-watt servomotors when used with 115-v. 400-cps. supply (ratings doubled with 230-v. 400-cps.). Output is sinoidal, amplitude-variable, and phase-reversible. Control by dual triode such as 12AU7. Response time approx. 7.5 millisec.—*United Transformer Co., 150 Varick Street, New York 13, N. Y.*

For more information circle **322** on inquiry card.

Galvanometer Amplifier

New "Model 2609" high-input-impedance galvanometer amplifier extends usefulness of piezoelectric acceleration, pressure, force, and other pickups; also strain gages, photocells, inductive pickups, etc. Sensitivity is flat to within 1 percent over frequency range from 1 to 20,000 cps. (without transformer) and from 5 to 5000 cps. with "Model 2609.1 Output Transformer" (accessory providing a low source impedance for use



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Microwave Antennae	Dynamics Testing
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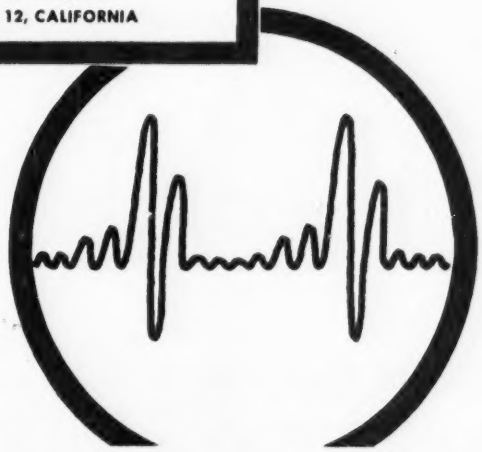
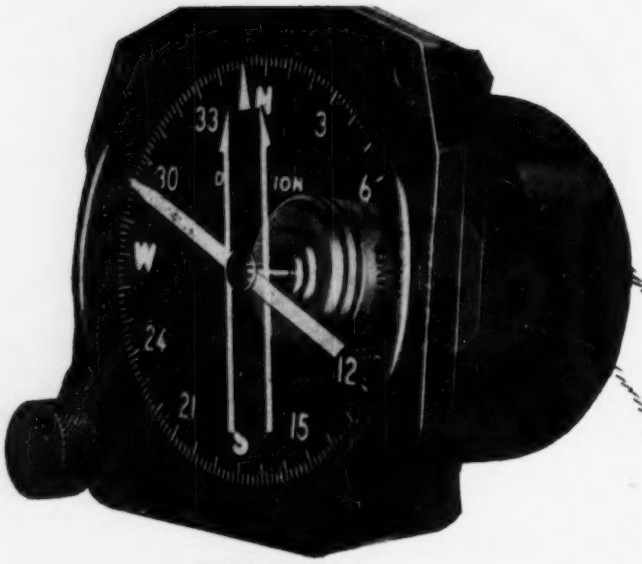




NEW **HIGH** ACCURACY

LOW WEIGHT

SYNCHRO RECEIVERS

Weight of this receiver is less than 2 oz.—torque exceeds 2,300 mg mm/degree—accuracy 30 minutes, total error spread. Used in conjunction with a Clifton transmitter, overall system errors of less than 40 minutes spread—±30 minutes approximately—are to be anticipated.

The same engineering team that developed the original 1.437" diameter high precision synchro has immediately available on a production basis these high torque high accuracy transmitter-indicator combinations at a saving of almost two-thirds the weight.

For full information on these and other units of this complete series of high accuracy Size #10, Size #11 and Size #15 units, write or telephone T.W. Shoop, Sales Manager, MAdison 6-2101. (Suburban Philadelphia)

cppc

CLIFTON PRECISION PRODUCTS COMPANY INC.

CLIFTON HEIGHTS 11 PENNSYLVANIA

For more information circle **73** on inquiry card.

NEW INSTRUMENTS

with high-frequency galvanometers and an output of 50 ma. peak-to-peak into a 17-ohm load). Without accessory transformer, an output of 14 ma. ptp. into 1000 ohms is available. Small size (1 x 3 x 5½ in. including shock-mount) permits use of new amplifier near pickup, minimizing length of high-impedance cable.—*Endevco Corp., 689 South Fair Oaks Ave., Pasadena 2, Calif.*

For more information circle **323** on inquiry card.

Pickup-output Amplifier

New "Type 1-127" four-channel carrier amplifier has a flat frequency response from 0 to 3000 cps.; has a

frequency range three times that available in any similar instrument; is particularly useful for reproducing outputs of resistance or reluctance type pickups in frequency range of 0 to 3000 cps. Accuracy is 1 percent for modulating frequencies from 0 to 3000 cps. Instrument will operate on 105-125 v.ac., 50, 60, and 400 cps.—*Consolidated Engineering Corp., Pasadena 8, Calif.*

For more information circle **324** on inquiry card.

POWER SUPPLIES

Regulated Power Supplies

New "Power in a package" units provide a wide range of power outputs from one compact cabinet. Arrangement permits incorporation of a variety of power supplies to meet individual work requirements. Unit illustrated provides regulated power, simultaneously, as follows: 0.600 v.dc. at 0.500 ma., 6 or 7 v.dc. at 1.5 to 15 amps, 110-120 v.ac. 0-1000 va. load range, all closely regulated.—*Sorenson & Co., Inc., 375 Fairfield Ave., Stamford, Conn.*

For more information circle **325** on inquiry card.

High-voltage Supply

New "Model 312," designed for precision scintillation counting, has a high degree of regulation (0.01 per-

cent for line change from 100 to 130 v.), is stable to approx. 0.02 percent per day. Successive experiments may be conducted without making corrections in settings or applying corrective factors. Range of output is variable from less than 200 v. to more than 1400 v. in 17 steps; max. current 1 ma. Special feature is positive or negative output through same connector; controlled by a front panel switch which also allows high voltage to be removed from connector without turning off supply.—*Atomic Instrument Co., 84 Massachusetts Ave., Cambridge 39, Mass.*

For more information circle **326** on inquiry card.

Adjustable Power Supply

New "Model 701" is an unregulated supply, providing d-c. voltages from zero to 250 at maximum load of 90 ma. (360 v.d-c. open circuit), and a-c.

filament power, 6.3 v. at 3 amps., center tapped. Ripple 20 mv.rms. An autotransformer in primary permits adjustment of d-c. output to any desired value from zero to maximum.—*Shasta Div., Beckman Instruments, Inc., P. O. Box 296, Richmond, Calif.*

For more information circle **327** on inquiry card.

Utility Power Supplies

New "5-200-C" (single unit) and "D5-200-C" (dual unit) are utility power supplies for laboratory and development use; have ratings ranging up to 500 v.dc at 200 ma. Single unit provides five different outputs; dual unit provides eight output combinations. Regulation on all units is 0.15 percent change per 10 percent line voltage, and 50 mv. change, no-load to full-load. Ripple is less than 2 mv. Recovery time is 0.1 millisecond maximum when full load is applied. Units are designed for rack mounting. —*Dressen-Barnes Corp., 250 N. Vinedo Ave., Pasadena 8, Calif.*

For more information circle **328** on inquiry card.

D-c. Power Supply

New 0-32 v. 25-amp. power supply features 1 percent regulation and a ripple of 1 percent rms.; unit is designed for 115-v.ac. input; weighs 130 lbs.; is 19 in. wide; has wide application in lab testing of aircraft d-c. systems, etc.—*Perkin Engineering Corp., 345 Kansas Street, El Segundo, Calif.*

For more information circle **329** on inquiry card.

Aircraft D-c. Supply

New "Model MRP-5-1 Stablvolt" d-c. power supply unit using no vacuum tubes or moving parts has been designed for aircraft, drone target, and missile applications. D-c. output voltage is practically free of 115-v. 400-cps. line voltage transients by

Circle **74** on inquiry card. ⟶

THERE'S MORE FOR YOUR MONEY··IN

PANALARM "50" ANNUNCIATOR SYSTEMS

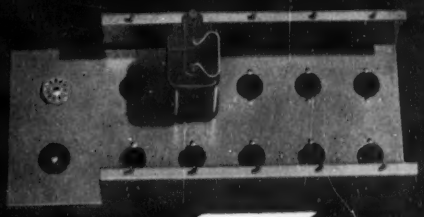
No annunciator system ever offered as much in value as PANALARM "50".

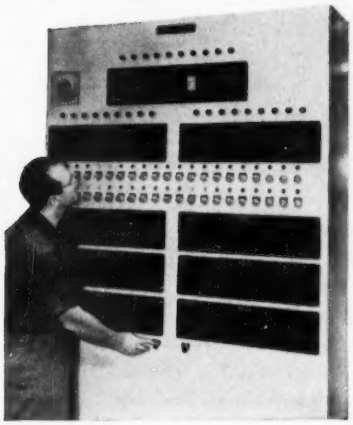
Examine for yourself every piece and component . . . consider the savings you realize through standardization and complete flexibility that only PANALARM "50" provides.

Then, evaluate *dependability*. Beyond all else, PANALARM "50" represents the greatest value in audio-visual alarm systems by its record of *dependable service* alone.

STANDARD CHASSIS

is interchangeable without re-wiring for all types of annunciator service: standard audio-visual; ringback; bullseyes or nameplates; trouble or running signals; lock-outs; or low drain operation.





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In hundreds of plants—serving for many years—Panalarm Annunciators have demonstrated outstanding performance. They have won confidence for the very critical part they play in plant operation and safety.

PANALARM PLUG-IN UNITS

. . . *heart of the system* . . . incorporate finest telephone-type relays and, special contact arrangements . . . assure sequential operation. Hermetically sealed suitable for Class I, Div. 2 locations.

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Ask for Catalog 100-A

PANALARM PRODUCTS, INC.

7405 N. HAMLIN AVE.
SKOKIE, ILLINOIS

PANALARM

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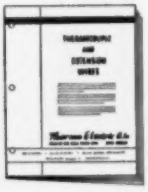
WHAT'S SO IMPORTANT ABOUT THE LABEL?
ThermoElectric WIRE
LENGTH 2000 Ft.
TYPE | GAGE | CAL
PN | 16 | A
OVERALL COLOR | BLACK
POSITIVE (+) | IRON | WHITE
NEGATIVE (-) | CONSTANTAN | RED
ThermoElectric
IT SHOWS HOW CAREFUL T-E IS WITH ITS THERMOCOUPLE & EXTENSION WIRES.

Here's how a reel of T-E wire looks after you unwrap it. The easy-to-read label can save valuable time when you must know, and know quickly, what kind of wire is on the reel. The label tells you not only wire type, length, and polarity, but insulation colors too. Therefore, you can identify conductors easily by comparing colors listed on the label with those on the wire itself.

As you can see, it's a well-thought-out label. Important by itself, it's also a revealing illustration of the care T-E takes. Thoroughness is characteristic of every step in T-E's wire production, from drawing and calibrating to insulating. The result of such care is a product which meets high industrial standards.



There are too many T-E wires to mention comfortably in one ad. However, in T-E's 8-pg. Wire Bulletin you can see insulations, gages, and calibrations, as well as charts with calibration symbols, color codes, insulation characteristics, resistances, weights, electrical properties, and conduit capacities. Write for Bulletin 31-F.

Pyrometers • Thermocouples • Protection Tubes • Quick-Coupling Connectors
Thermocouple and Extension Wires • Resistance Bulbs • Connector Panels

Thermo Electric Co., Inc.
SADDLE RIVER TOWNSHIP, ROCHELLE PARK POST OFFICE, NEW JERSEY
IN CANADA—THERMO ELECTRIC (Canada) Ltd., BRAMPTON, ONTARIO

For more information circle **75** on inquiry card.

NEW INSTRUMENTS

utilizing maker's dual magnetic regulation circuitry. Output capacity 5 v. at 1 amp.—*Magnetic Research Corporation, 200-202 Center St., El Segundo, Calif.*

For more information circle **330** on inquiry card.

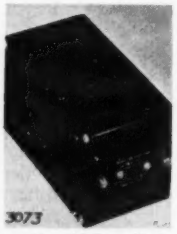
Klystron Power Supply

New "Klystron Tube Power Supply," said to be first unit of its kind to be placed on the market, provides interior accommodation for 2K39, 2K41, 2K42, 2K43 and 2K44 type klystron tubes; provides all four necessary voltages: reflection, beam, control electrode and heater; also provides for exterior connections for other types of klystron tubes.—*Dressen-Barnes Corp., 250 N. Vinedo Ave., Pasadena 8, Calif.*

For more information circle **331** on inquiry card.

ELECTRICAL AND ELECTRONIC COMPONENTS

Resolver System



New resolver system for 400 cps. has 0.25-to-14-volt range, two channels, 9-db gain margin (low and high freq.), 35 deg. phase margin (low and high freq.). Power: B+ 10 watts (150 v.), fil. 9.5 watts (6.3 volts). At frequencies between 380 and 420 cps., phase shift is 1 minute and magnitude variation 0.0002.—*Ketay Mfg. Corp., 555 Broadway, New York 12, N. Y.*

For more information circle **332** on inquiry card.

Junction Diodes

Three new germanium junction diodes provide high forward conductances (up to 300 ma. at 1 volt), high reverse resistances, exceptional electrical and mechanical stability and freedom from hysteresis, drift, flutter, etc. "CK741" and "CK747" with low forward impedance and high ratios of reverse to forward resistance are useful for computer and similar applications; "CK745" is rated for a peak inverse voltage of 125 v.—*Raytheon Mfg. Co., 55 Chapel St., Newton, Mass.*

For more information circle **333** on inquiry card.

Selenium Diodes

Four new subminiature selenium diodes, "Types 4V1, 5V1, 2Y1, and 3Y1," are rated for a maximum a-c. input voltage (rms) from 52 to 130 v. and for maximum d-c. output voltage of 60 to 80 v.; will deliver output current from 5 to 11 ma. Each diode is encapsuled in thermosetting plastic and may be operated in an ambient temperature range of –50 C. to 100 C.—*International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.*

For more information circle **334** on inquiry card.

Miniature Pentode

New "CK6485" is a heater-cathode type, high-transconductance, sharp cut-off pentode of miniature construction designed for use as a wide band or IF amplifier. It will maintain its emission and freedom from excessive cathode interface resistance after long periods of operation under cut-off conditions. Electrically it is like maker's "6AH6."—*Raytheon Mfg. Co., 55 Chapel St., Newton 58, Mass.*

For more information circle **335** on inquiry card.

Medium-mu Twin Triode

New "5965" is a medium-mu twin triode of 9-pin miniature type especially designed for frequency-divider circuits in electronic computers, and other "on-off" control applications involving long periods of operation under cut-off conditions. Tube has separate terminals for each cathode to facilitate flexibility of circuit arrangement, and a mid-tapped heater to permit operation from either a 6.3-v. or 12.6-v. supply.—*Tube Div., Radio Corporation of America, Harrison, N. J.*

For more information circle **336** on inquiry card.

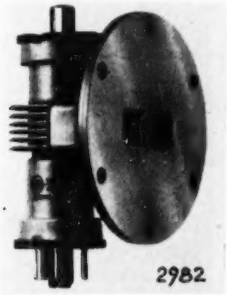
Phototube

New "6405/1640" gas phototube is designed for use in industrial applications critical as to microphonics and sensitivity gradient. Spectral response being characterized by high sensitivity to red and near-infrared, tube is especially suitable for use with an incandescent light source.—*Tube Div., Radio Corporation of America, Harrison, N. J.*

For more information circle **337** on inquiry card.

Relay Klystron

New "VA-220" relay klystron for 6000-8000-Mc. band is offered at half the cost of maker's "X-26" klystrons.



Performance exceeds that of "X-26." Features include ample power to override noise, negligible frequency drift, easier tuning, FM distortion and inherent noise 60 db below a 1-Mc. deviation, and production uniformitv. —*Varian Associates, Palo Alto, Calif.*

For more information circle **338** on inquiry card.

Delay Lines

New Miniature Distributed Constant Delay Lines are suited for use in delaying trigger pulses, pulse-forming networks in conjunction with thyratrons or blocking oscillators, pulse-width discrimination, etc.; meet MIL-T-27 specs. At an impedance level of 500 ohms, units are available

Original Thinking plus Precision Components

Kearfott Firsts

1947 First with "Penny Size" Servo Motors .938" diam. x 31/32" long.

1948 First with Servo Motors in Navy BuOrd Sizes 15 and 18 featuring straight-thru bores and integral ("potted")* stator-housing assemblies.

1949 First with Navy BuOrd Size 11 Synchros featuring "potted"* stator construction and straight-thru bores.

1950 First with Navy BuOrd Size 11 Servo Motors featuring "potted"* stator construction and straight-thru bores.

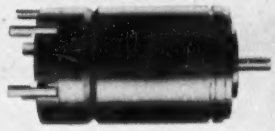
1951 First with Navy BuOrd Sizes 15 and 18 Servo Motor—Rate Generator combinations featuring "potted"* stator construction and straight-thru bores.

1952 First with temperature stabilized Drag Cup Motor-Integrator Generator combinations in Navy BuOrd Size 15 featuring "potted"* stator construction and straight-thru bores.

1953 First with Servo Motor-damping Generator combinations in Size 11 featuring "potted"* stator construction and straight-thru bores.

1954 First with 3/4" Diam. "Penny-Size" Servo Motors and Synchros. First with .05% linearity Tachometer Generators in Size 18. First with 115 volt Servo Motor Generator .980" in diameter. All Featuring "potted"* stator construction and straight-thru bores.

3/4" DIA. SERVO MOTOR—FULL SIZE



R500 SYNCHRO—3/4 SIZE

R804 SERVO MOTOR-GENERATOR—1/2 SIZE

3/4" DIA. SYNCHROS—FULL SIZE

*"Potted" construction for optimum performance at lowest cost.

All items discussed and illustrated are in production—available to you for your prototype, preproduction or production systems. Write today for more detailed information.

KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components.

Send for Bulletin giving data of components of interest to you.

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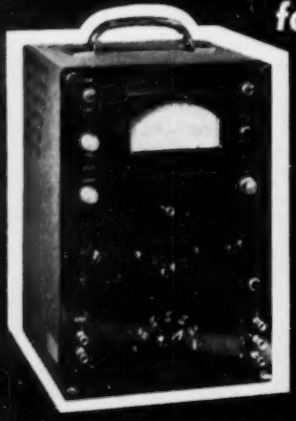
For more information circle **76** on inquiry card.

SIE

MODEL R-1

VOLTMETER

Designed and Engineered for Design Engineers

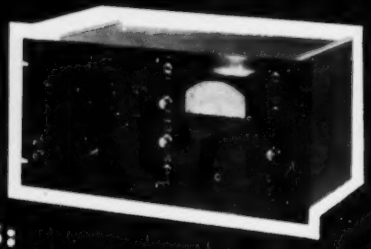


FEATURING:

- ★ DC Volts & Millivolts — Accurate to 1½% of full scale
- ★ AC Volts & Millivolts — Accurate to 3% of full scale
- ★ Balanced D-C Amplifier — Flat ±½ db. to 100 KC
- ★ Ohmmeter — with Expanded Scales
- ★ Regulated Power Supply — unaffected by line transients
- ★ Illuminated Weston Meter — accurate to 1% of full scale

. . . and the SIE Distended DC Scales, the most useful feature ever incorporated in a vacuum-tube voltmeter, enabling changes as small as one part in 10,000 to be read accurately.

The new rack-mounted version of the R-1 includes all of these features in a unit specially designed for this application.



SPECIFICATIONS:

AC & DC Volts Ranges: 1 mv. to 1000 v., full scale
Ohmmeter Ranges: zero ohms to 500 megohms
Maximum Gain, D-C Amplifier: 200
Drift (after warm up): less than 3 mv./hr.
Tube complement: 13
Weight: 34 lbs.

Price, f.o.b. Houston: **$620.00**

rack mounted: **700.00**

SIE

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P. O. Box 13058 — 2831 Post Oak Rd.

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REPRESENTATIVES THROUGHOUT THE WORLD

54-1

For more information circle **77** on inquiry card.

NEW INSTRUMENTS

in 1, 2, 4 and 6 usec. time delay; unusually short rise times of 0.1, 0.15, 0.25, and 0.3 usec.; attenuations from 0.416 to 3.208 db. Units withstand maximum d-c. pulse voltage of 700 and a maximum operating temperature of 125 C. Signal distortion runs about 15 percent. Standard length 4.06 in.; various heights and widths.—*PCA Electronics Inc.*, 2180 *Colorado Ave., Santa Monica, Calif.*

For more information circle **339** on inquiry card.

High-*Q* Coils

New coils, designed to provide extremely high *Q*'s at low frequencies, use a special laminated structure (instead of powder) which provides a *Q* of approx. 45 at 100 cps. and approx. 20 at 20 cps. Heavy "Hipermalloy" shield and shielded-gap internal structure assure low hum pickup. Two identical windings permit series, parallel, or center-tapped connection, hence four standard types; inductances from 2.5/10 to 100/400 henries.—*United Transformer Co.*, 150 *Varick St., New York* 13, *N. Y.*

For more information circle **340** on inquiry card.

Selenium Rectifier

New selenium rectifier with an inverse cell rating of 40 volts is said to combine 40-v. rating with low leakage (2 ma./sq. in. average); low inverse loss; heating at high voltage averaging less than 5 C.; high dielectric quality, with ability to withstand surges up to twice rated voltage. Operates in ambient temperatures to 125 C., with no derating for 50 C.—*Vickers Electric Division*, 1817 *Locust St., St. Louis* 3, *Mo.*

For more information circle **341** on inquiry card.

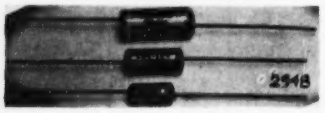
Inverters

Two new models of inverters, for operation from 6- or 12-v. storage batteries in vehicles, provide 110-v.ac. 60-cps. in various wattage for operation of dictating machines, recorders, radios, test equipment, etc. Other models available for operation from other dc. inputs to 220 v.dc.—*American Television & Radio Co.*, 300 *E. Fourth St., St. Paul, Minn.*

For more information circle **342** on inquiry card.

Miniature Capacitor

New model of maker's low-cost plastic film miniature capacitor is



smaller; withstands severest environmental tests.—*Plastic Capacitors, Inc.*, 2511 *W. Moffat St., Chicago* 47, *Ill.*

For more information circle **343** on inquiry card.

Ultraminiature Capacitors

New "Type 103D Tantalex" units are ultraminiature (⅛ x 5/16 in.) electrolytic capacitors employing tantalum as anode; are said to be ideal for low-voltage applications where they provide relatively large values

of capacitance in minimal space. Recommended for bypass, coupling, and filter applications in low-voltage transistor circuits; also transistor hearing aids and military amplifiers. Operating temperature range is –20 to 65 C.—*Sprague Electric Co.*, 43 *Marshall St., North Adams, Mass.*

For more information circle **344** on inquiry card.

200-deg. C. Capacitor

New capacitor employs high-polymer plastic film dielectric which is stable up to 200 C. Units are cased in

a tubular metal container with hermetic glass end seals; axial leads. Temperature coefficient less than 75 ppm. from –70 C. to 200 C.; power factor less than 0.0005 even in VHF band; no deterioration in this performance after 13,000 hours at 200 C. and 140 percent of rated voltage. Standard ratings from 0.0003 to 1.0 mfd.—*Balco Research Laboratories*, 49-53 *Edison Pl., Newark, N. J.*

For more information circle **345** on inquiry card.

High-temperature Capacitor

New "Hy-Therm subminiature high-temperature capacitor, hermetically sealed and metal-encased, is available in all standard values and tolerances, for all applications requiring exceptionally high insulation resistance and unusual stability at high temperatures. Insulation resistance quality exceeds Mil-C-25A.—*Hopkins Engineering Co.*, 2082 *Lincoln Ave., Altadena, Calif.*

For more information circle **346** on inquiry card.

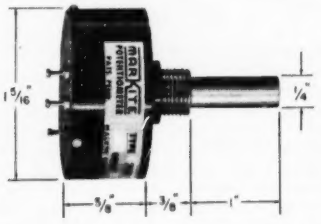
High-temperature VDR

New "Type 415" continuously-variable wire-wound voltage-dividing resistor will operate at ambient temperatures of over 125 C. and still maintain rated performance characteristics. New low-mass wiper permits operation under severe vibration and acceleration conditions. New coupling for ganging cups provides zero backlash and low torque.—*The Daven Co.*, 191 *Central Ave., Newark* 4, *N. J.*

For more information circle **347** on inquiry card.

High-resolution VDR

New "Type 2094 Rotational Potentiometer" features substantially infinite resolution and low noise under



extreme vibration and acceleration; carries a life guarantee of 5 million revolutions at 600 rpm. or less. Active element is conductive plastic, integrally co-molded to terminals, taps and a rigid supporting phenolic insulator plastic. Available values 2000 to

OMNIGUARD – simplest and most flexible temperature monitoring system yet devised – safeguards industry. Wherever power is generated . . . wherever chemical processes are in motion . . . wherever machinery is in operation, **OMNIGUARD**, with unique "building-block" construction, pinpoints the vital "hot" points reached by Edison resistance temperature detectors.

Designed and developed at the world-famous Edison Laboratory, only **OMNIGUARD** has these new, *exclusive* features:

▶ **Constant protection** – All points are "on-guard" at all times. Instant alarm the moment critical temperature is reached–*without scanning mechanisms* or codes.

▶ **Individual alarm point adjustment** – Each point has own alarm setting – can be adjusted on the spot without special tools.

▶ **Installation adaptability**–Group the units close to protected equipment – or in control room with minimum wiring and at lowest installation cost.

▶ **Equipment flexibility**– Basic monitor units handle as few as four points. More points can be added at any time. One indicator serves multiple points.

▶ **Design simplicity** – System monitors without moving parts–nothing to "wear" out. No electronic tubes or complex circuits.

Write us, won't you, for more specific information on *your* heat control problem?

Thomas A Edison

A GREAT NAME CONTINUES GREAT NEW ACHIEVEMENTS

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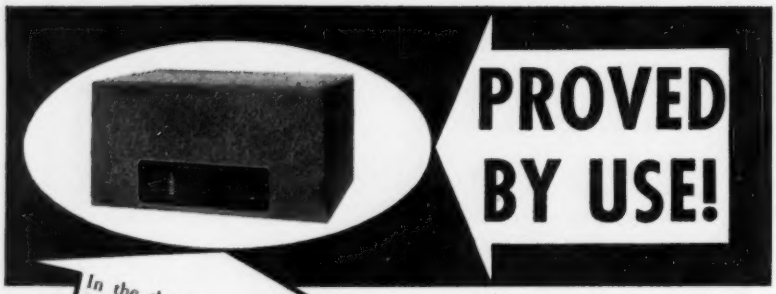
For more information circle **78** on inquiry card.



PROVED BY USE!

In the short time the Model 1001 Regulator has been on the market, more than 300 of the instruments have been sold, mainly for meter calibration applications and for use in standards laboratories.

As a result, it can now be said — and proved — that the Model 1001 gives hairsplitting precision with the rugged dependability of operation associated with voltage regulators of "ordinary" regulating accuracy!

0.01% regulation accuracy!

1000 VA capacity!

Sorensen Model 1001

electronic AC Voltage Regulator

specifications

Input	95-130 VAC, 1ϕ, 50-60∿
Output	110-120 VAC, adjustable
Load range	0-1000 VA
Regulation accuracy	±0.01% against line and ±0.01% against load guaranteed at room temperature, for a resistive load, an input variation of ±10% and over a 2-to-1 load change. For all other conditions within the specifications the 1001 has a proportionate amount of accommodation.
Distortion	3% RMS maximum
P. F. range	0.95 leading to 0.7 lagging
Time constant	0.1 second
Tube complement	6SL7GT (1), 6L6GA (1), 5Y3GT (1), 2AS15 (1)

Even greater capacity with similar accuracy will be available this fall when the Sorensen Model 2501 Regulator — ±0.01% accuracy, 2500 VA capacity — goes into production.

general catalog available

AC VOLTAGE REGULATORS — 150VA to 15000VA capacities, 115 volt and 230 volt output, 400-cycle regulators, 3-phase regulators

FREQUENCY CHANGERS — 60 cycle and 400 cycle, accuracy to ±0.01%

NOBATRONS — Regulated low-voltage, high-current DC sources

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AIRBORNE FREQUENCY CHANGERS & INVERTERS, MILITARIZED REGULATORS, FILTERS, TRANSFORMERS, AND RELATED EQUIPMENT.

For your copy write Sorensen & Co., Inc., 375 Fairfield Avenue, Stamford, Conn. In Europe, Sorensen A.G., Gartenstrasse 26, Zurich 2, Switzerland.

SORENSEN

375 FAIRFIELD AVENUE, STAMFORD, CONN.

For more information circle **79** on inquiry card.

NEW INSTRUMENTS

100,000 ohms; linearity of 1.0 or 0.5 percent. ★Rectilinear motion units are also produced with maker's conductive plastic resistance elements.—*Markite Corp., 155 Waverly Place, New York 14, N. Y.*

For more information circle **348** on inquiry card.

Ten-turn VDRs

New "Series AJ" of "Helipot" 10-turn miniaturized (1½-in. long) precision voltage dividing resistors are available in linear and non-linear versions, for servo or bushing mounting; contain a mandrel-wound resistance element 18 in. long, providing resolution as fine as 0.01 percent. Linear versions have standard resistance ranges of 25 to 100,000 ohms; standard linearity tolerance 0.5 percent; 0.1 percent on special order. In non-linear versions, standard conformity tolerance for most functions is 1 percent. Much closer conformity on special order. Terminals are gold-plated. Power rating is 2 watts at 40 C. ambient.—*Helipot Corp., 916 Meridian Ave., South Pasadena, Calif.*

For more information circle **349** on inquiry card.

Shock-proof Resistors

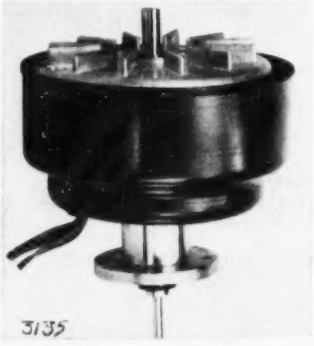
New "Type L" resistors are specifically designed for extremes in humidity, altitudes and corrosive influences; but will also withstand severe shock and vibration. Furnished with lug type terminals or wire leads; in a complete line of standard, midget, and sub-miniature sizes. Wide range of performance.—*Resistance Products Co., 714 Race St., Harrisburg, Penna.*

For more information circle **350** on inquiry card.

ELECTROMECHANICAL COMPONENTS

Mag-tape-drive Motors

New low- and high-speed direct-drive synchronous motors feature synchronous speeds from 300 to 1800

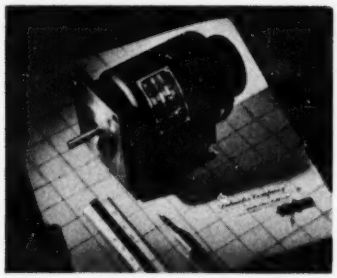


rpm.; combine a high-torque rotor with flywheel and precision ground capstan; provide accurate and constant tape velocities for magnetic recorders without gear reductions.—*Technical Development Corp., 4060 Ince Blvd., Culver City, Calif.*

For more information circle **351** on inquiry card.

Constant-speed Motor

New "Type SC-23" maintains governed speed of 7,100 rpm ±1.0 percent from 24 to 30 v.dc. with load



variations of ±30 percent; meets all military specs for temperature, pressure, and humidity requirements in airborne equipment; is rated at ⅛ hp.; provides locked-rotor torque of 9⅝ lb.-in.—*Dalmotor Co., 1343 Clay St., Santa Clara, Calif.*

For more information circle **352** on inquiry card.

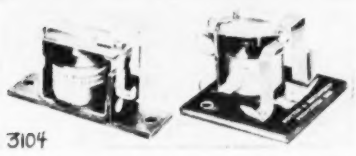
Servo Components

New line of precision electronic and mechanical servo components for use in standard servo and computer assemblies is said to be complete. Mechanical components include friction clutches, gear boxes, gears, cams, mounting brackets, and base and upright plates. Light-weight electronic components (building-block plug-in type) include servo and summing amplifiers which are high-gain low-phase-shift units; and phase and linear phase detectors said to be highly accurate and sensitive units requiring no adjustment, tube selection or balancing.—*Link Aviation, Inc., Hillcrest, Binghamton, N. Y.*

For more information circle **353** on inquiry card.

Plate-circuit and Appliance Relays

New "Series LB" low-cost long-life plate circuit relay (left) is available in coil resistances up to 34,000 ohms with a pull-in rating of 3 ma. (approx. 0.09 watt). One-piece back spring and



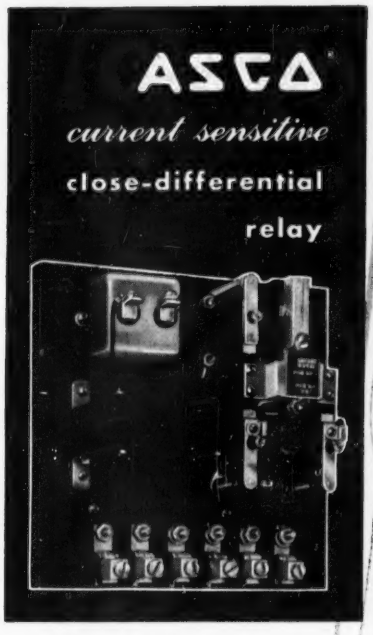
3104

contact arm can be adjusted for desired pull-in. Permanent air armature gap eliminates residual sticking. Contacts are silver, s-p.d-t. (1 Form C), rated 5 amps. (¾ hp) 115-v.ac. non-inductive. ★ New "Series MW" (right), designed primarily for appliances, is available with varnish-impregnated a-c. or d-c. current- or voltage-actuated coils. Large silver contacts afford substantial wiping action and are rated 5 amps. (¾ hp), 115-v.ac. non-inductive. Heavy copper shading ring prevents chatter and hum.—*Potter & Brumfield, Princeton, Ind.*

For more information circle **354** on inquiry card.

Electronic Relay

New "MEK-2403," for industrial use, will operate dependably with relatively poor initiating contacts: up to almost one megohm can be allowed;



process *control* by motor current *measurement*

This Relay offers wide possibilities for automatic control problems. Why not investigate it for use with your process or equipment?

- **2% SENSITIVITY**
- **CONTINUOUS DROP-OUT ADJUSTMENT**—with factory-set pickup. (Also designed with a continuous pickup adjustment.)
- **SUPPLIED IN ANY POLE COMBINATION**—to 2 normally open, 2 normally closed.
- **OPEN OR ENCLOSED**
- **ELECTRICAL RATINGS**—Contacts rated 5 amps Continuous Current, 600 Volts Maximum; Coils to 60 Amp. Capacity—higher when supplied with current transformers.
- **VOLTAGE-TYPE AVAILABLE**—comparable construction and operating characteristics.
- **SPECIAL MODIFICATIONS**—high shock designs, variable pickup, frequency response, delayed action, etc.

Mixing a batch?

Assume you have a batch mixing process where the viscosity increases progressively as the batch nears completion. The current drawn by the driving motor will increase with the viscosity. An ASCO Close-Differential Relay could be used to automatically open the motor control circuit at the exact batch viscosity desired. This would be accomplished by merely calibrating relay operation to the current corresponding to desired viscosity.

In general, this ASCO Relay can provide a triggering impulse or trip in systems designed to control innumerable operations where electric motors are the power source or where current variations occur. Such systems include devices for the control of polymerization, measurement of viscosity, regulation of flow, etc.

when you can predict a current variable . . . consider an ASCO Close-Differential Relay for your automatic control.

FOR COMPLETE INFORMATION—Send for our Publication 69R1 on ASCO CLOSE-DIFFERENTIAL RELAYS.

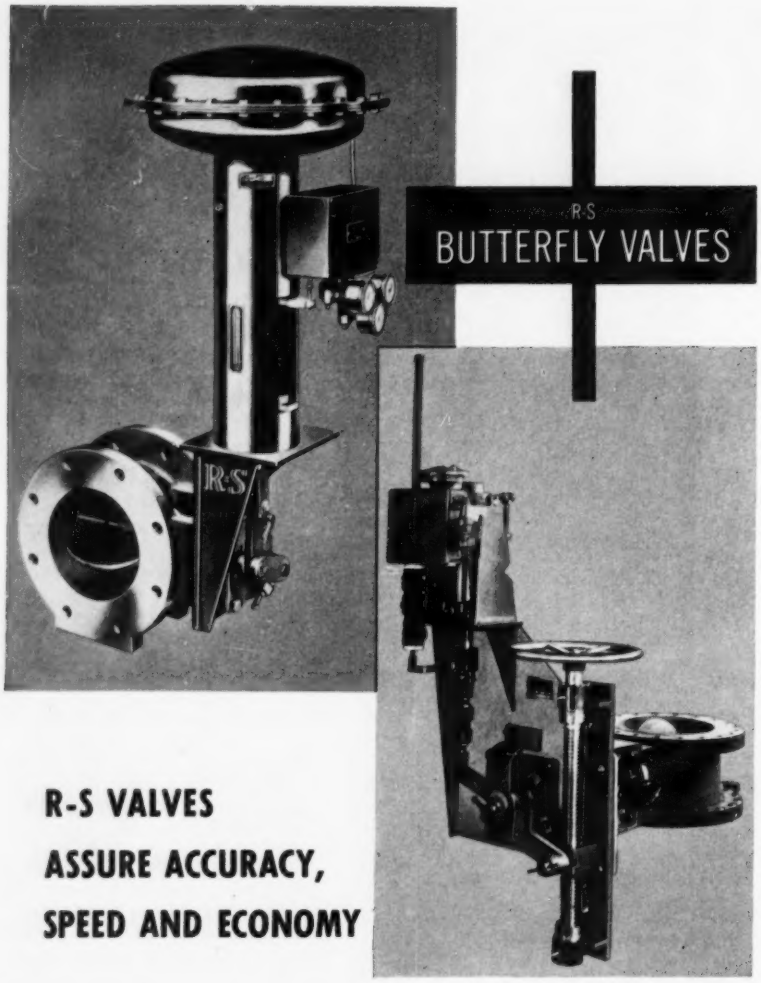
ASCO Solenoid VALVES

ASCO Electro-Magnetic CONTROLS

Automatic Switch Co.

385-T Lakeside Avenue, Orange, N. J. • ORange 2-5300

For more information circle **80** on inquiry card.



R-S VALVES ASSURE ACCURACY, SPEED AND ECONOMY

With automatic controls – R-S Valves will give the most positive and dependable performance obtainable . . .

UNIFORM CONTROL IN ALL POSITIONS . . .
R-S Valves give consistent flow control through all positions in the normal regulating range. The disc simulates a straight line, semi-log characteristic. Cam-driven positioners can furnish other characteristics as required.

REGULATION AND CLOSURE ARE QUICK . . .
Power actuation provides fast or slow regulation-time.

MINIMAL PRESSURE DROP SAVES POWER . . .
In open position the streamlined disc effects less pressure drop than many types of valves. This will show considerable reduction in pumping costs.

S. Morgan Smith offers the best in valve engineering for your control applications. To find the proper valve for any application, or to get additional information on our complete line of butterfly, ball and cone valves, write to the S. Morgan Smith Company, York, Pennsylvania.

Hydraulic Turbines · Pumps · Gates & Hoists · Trash Rakes · Accessories

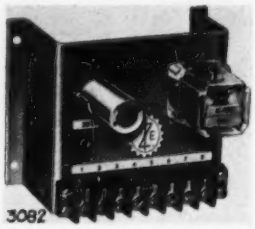
HYDRODYNAMICS

Rotovalves · Ball Valves · Butterfly Valves · Free-Discharge Valves · Controllable-Pitch Ship Propellers

S. MORGAN SMITH CO.

For more information circle **81** on inquiry card.

NEW INSTRUMENTS

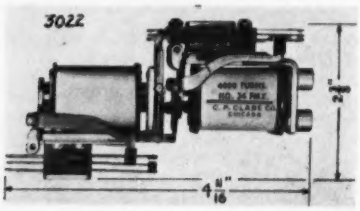


and this controlling-contacts resistance can vary widely from one operation to the next. Control circuit voltage and current are extremely low: no arcing; and unprotected contacts do not present a hazard.—*Machinery Electrification, Inc., Northboro, Mass.*

For more information circle **355** on inquiry card.

Latching Relay

New "Type G" electromechanical latching relay has life expectancy of millions of operations instead of thousands. Assembly comprises two relays

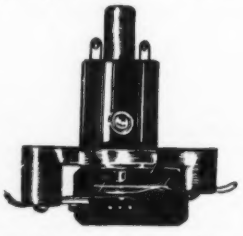


with interlocking armatures. When either relay is energized while the other (deenergized) is latched up, it will unlatch the other, allowing it to restore, and will latch itself up. When either is energized while the other is already energized, it will operate its own contacts without latching up and without affecting the other. It will release as soon as its coil circuit is opened. (Both, however, can be interlocked electrically so that both coils cannot be energized at once.) When either relay is deenergized while the other is energized, the other will become latched up.—*C. P. Clare & Co., 3101 West Pratt Blvd., Chicago 45, Ill.*

For more information circle **356** on inquiry card.

High-voltage Converter

New "MVT" miniature high-voltage converter weighs less than 3 oz., is small enough to fit in palm of hand; delivers any voltage from 0 to 7,000



by connecting one or two dry cells to input; works equally well on a.c. Circuit diagrams supplied with each unit show suggested hookups, including stabilizer circuits that provide regulation of 2 percent or better.—*Precise Measurements Co., 942 Kings Highway, Brooklyn 23, N. Y.*

For more information circle **357** on inquiry card.

400-cps. Circuit Breaker

New 400-cps. circuit breaker, said to be the first for protection of polyphase circuits, meets demand for minimal bulk and weight; minimizes hysteresis, eddy current and skin-effect difficulties. Polyphase operation is accomplished by new "Companion-Trip" principle whereby two or three single-pole circuit breakers in a common assembly are linked together externally at handles. Breaker operates on maker's hydraulic-magnetic principle whereby current capacity, minimum and instantaneous trip points are constant, regardless of ambient temperature: operation based solely on current value. No thermal elements. Sesection of time-delay response curves. Available in one, two or three-pole models; in any rating from 100 ma. to 50 amps.—*Heinemann Electric Co., 548 Plum St., Trenton 2, N. J.*

For more information circle **358** on inquiry card.

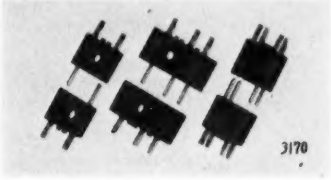
Solderless Terminals

Two new styles have been added to maker's line of "Faston" solderless "push-on" type connectors, fit standard ¼-in. tabs: (1) smaller wire size "Faston" for wire sizes No.22-No.18, designed primarily for wire cost reduction programs; (2) large insulation support "Faston" used on wire sizes No.16-No.12 handles insulation between 0.210 and 0.265 in.—*Aircraft Marine Products, 2100 Paxton St., Harrisburg, Penna.*

For more information circle **359** on inquiry card.

Miniature Connectors

New "Series G-20" high-potential miniaturized "Continental" connectors, designed for space-saving side mounting, are available with 2, 3, and



4 contacts. Sockets are of spring-temper phosphor-bronze; pin contacts are of brass; both are gold-plated over silver.—*Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City, 1, N. Y.*

For more information circle **360** on inquiry card.

Pressure-tight Connector

New "CM5-2" miniature electrical connector with back cable entry is pressure-tight with die-cast aluminum shells for maximum mechanical pro-

Plan NOW to attend the first

International Automation Exposition

at the 244th Regiment Armory
New York City

NOVEMBER 29—DECEMBER 2

Check Inquiry Card for registration blank

SHOW TEMPERATURE AT THE CONTROL PANEL

WARN OF TROUBLE WHEN IT STARTS — USE SIMPLYTROL INDICATING PYROMETERS.

4½" Cat. #4511
3¾" Cat. #1654
2½" Cat. #2613

WHITE FACE

Medium resistance pyrometers (4 ohms per millivolt). Automatic, bimetal cold junction correction. Compensated for copper error. With adjusting resistor to take thermocouples up to external resistance shown in table. When specified will be adjusted for mounting in steel panel. Accuracy 2%.

Contact pyrometers have same size and appearance but include contacts, adjustable to close at any place on the scale arc. Ask for Bulletin G-5.

Model B

Model C

PORTABLES

Any of these pyrometers can be supplied in the Model B carrying case or in the Model C bench stand. Ask for Bulletin G-3.

4½" Cat. #4514
3¾" Cat. #1652
2½" Cat. #2612

BLACK FACE

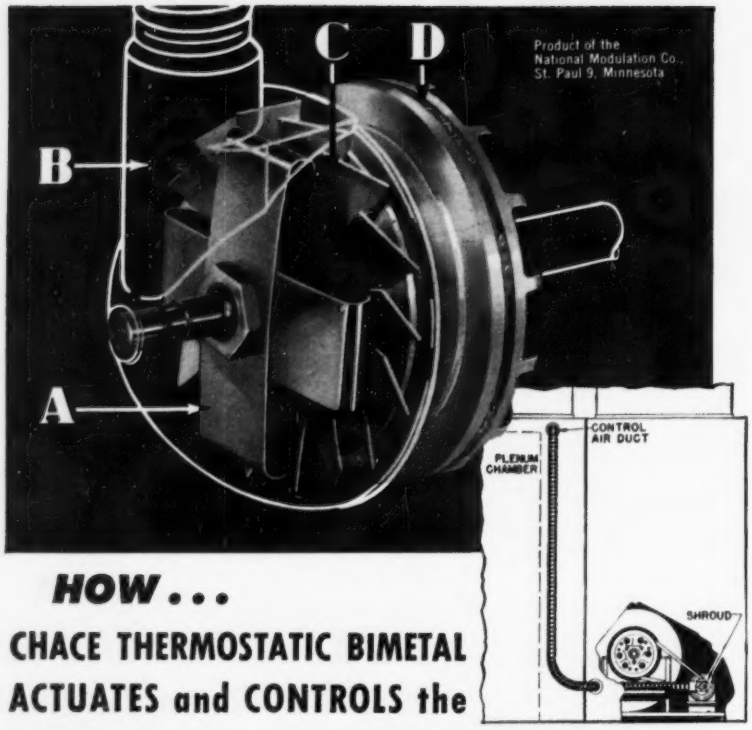
Temperature Range Degrees		Int. Res.	Ext. Res.	Thermo-couple	2½ inch Size 261 Cat. No.	Price	3¾ inch Size 351 Cat. No.	Price	4½ inch Size 451 Cat. No.	Price
0—3000° F	0—1650° C	70	10	Pt13%Rh	2618	$19.90	1658	$22.75	4518	$30.25
0—2500	0—1370	212	10	C/A	2611	18.40	1651	21.25	4511	28.75
0—2000	0—1100	172	10	C/A	2616	18.40	1656	21.25	4516	28.75
0—1500	0— 800	179	10	I/C	2612	18.40	1652	21.25	4512	28.75
0—1000	0— 500	112	10	I/C	2615	19.50	1655	21.80	4515	29.90
0— 750	0— 400	81	10	I/C	2614	19.50	1654	22.45	4514	31.05
0— 500	0— 260	52	8	I/C	2613	20.10	1653	23.00	4513	32.20
— 75 to 225	— 60 to 110	30	5	I/C	2617	23.00	1657	26.50	4517	35.65
—200 to 100	—130 to 40	30	5	C/C	2619	29.00	1659	32.50	4519	41.65

Several intermediate ranges not listed.

Thermocouples:—(not included). Chromel-alumel (C/A) 14 ga. insulated 5' leads $4.00. Iron-constantan (I/C) or copper-constantan (C/C) 20 ga. insulated 5' leads $2.90.

ASSEMBLY PRODUCTS, INC., P. O. BOX 191, CHAGRIN FALLS 10, OHIO

For more information circle **82** on inquiry card.



HOW...

CHACE THERMOSTATIC BIMETAL ACTUATES and CONTROLS the

PALM BEACH Comfort Control System

The PALM BEACH Comfort Control System is a completely self-contained unit which, when attached to the blower motor of a forced air heating system, regulates desired amounts of warm air circulation by driving the blower at variable speeds. Among the many advantages of this control are elimination of high rotative speeds of most blower systems and resultant drafts caused by frequent starts and stops. The PALM BEACH Comfort Control is actuated by Chace Thermostatic Bimetal which aids in vastly increasing overall efficiencies and fuel savings.

The bimetallic element (A) is attached directly to the shaft. As the temperature in the warm air plenum chamber begins to rise due to burner operation and exceeds 80° F., warm air is drawn into shroud (B) by rotating suction fan (C). Sufficient tension is created in the bimetal to energize clutch (D), causing the blower to start at very slow speeds. As the temperature continues to rise, the Chace Bimetal, reacting in direct proportion to the amount of heat present, increases the pressure on the clutch, allowing the blower to speed-up.

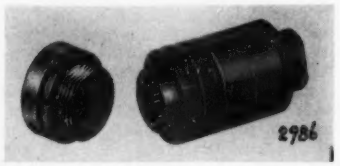
Chace furnishes thermostatic bimetal in 29 types, in strip, coil or in complete elements, fabricated and assembled to your specifications. Before development of your new controlling, indicating or protecting device, read our booklet, "Successful Applications of Chace Thermostatic Bimetal," containing valuable engineering data. Write for your free copy today.

W. M. CHACE CO.
Thermostatic Bimetal
1609 BEARD AVE., DETROIT 9, MICH.

For more information circle **83** on inquiry card.

NEW INSTRUMENTS

tection. Individual synthetic rubber O-rings around each contact provide pressure sealing while allowing contacts to "float," thereby precluding



alignment difficulties. Five #20 A.W.G. contacts (5 amps.) and two #18 A.W.G. contacts (7 amps.) Contacts are gold-plated over silver.—*Dep't R, Winchester Electronics, Inc., Glenbrook, Conn.*

For more information circle **361** on inquiry card.

Miniature Connector

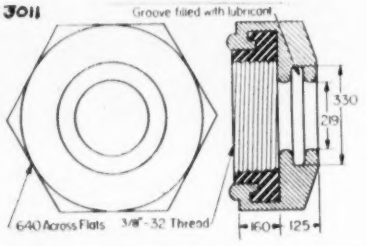
New "Series 20T" of maker's "Series 20 Miniature Connector" is available with turret terminals and up to 104 contacts. Two #20 AWG wires can be soldered easily to one contact. Aluminum hoods and polarizing screwlocks, available with "Series 20," also fit "20T."—*Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.*

For more information circle **362** on inquiry card.

MECHANICAL COMPONENTS

Hermetic Seals for Rotary Switches and Shafts

New "Hexseal 9000 Series" replace mounting nut in front of panel; seal out moisture, dust and combustible vapors. Seal consists of a grooved nut



to which is molded a silicone rubber boot. A gasket-rib seats against panel, and two "O"-ribs form a double seal against shaft.—*Automatic & Precision Mfg. Co., 252 Hawthorne Ave., Yonkers 5, N. Y.*

For more information circle **363** on inquiry card.

Variable-speed Drives

New models of "Zero-Max" infinitely-variable speed transmissions include such variations as double output shafts, both input and output shafts on same side of unit, and shafts opposite from standard unit. In addition, special speed control arms in various lengths are available for all models, as well as special control arrangements such as a spring return type.—*Revco Inc., 2 E. Franklin Ave., Minneapolis 4, Minn.*

For more information circle **364** on inquiry card.

VALVES

Midget Solenoid Valves

New "K-27, K-28 and K-29 Series" midget solenoid valves for handling all types of gases and liquids are available in many models for a variety of applications for control of fluids in domestic, commercial, and industrial fields. They include time delay valves, manual reset valves, two-way on/off valves and three-way valves; for gas, air, oil, water, as well as corrosive fluids.—*General Controls Co., 801 Allen Ave., Glendale, Calif.*

For more information circle **365** on inquiry card.

High-pressure Gas Valve

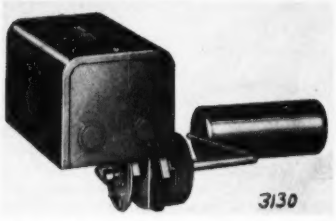
New "Hydramotor" valves are designed specifically for on/off control or safety shutdown of gas-fired industrial and commercial burners; are operated by a specially-designed electro-hydraulic pump; operate in 5-psi. to 35-psi. range; feature extremely rapid shutoff combined with a slow opening cycle. Operating mechanism is completely immersed in oil. Available housings include weatherproof, explosion-proof and dust-proof types. All types of gas, including sour and sulphur type gases, can be controlled without damage to valve.—*General Controls Co., 801 Allen Ave., Glendale 1, Calif.*

For more information circle **366** on inquiry card.

MISCELLANEOUS

Screw-in Tank Alternator

New screw-in tank alternator for condensate pumps mechanically alternates operation of two pumps installed in a duplex system with a common

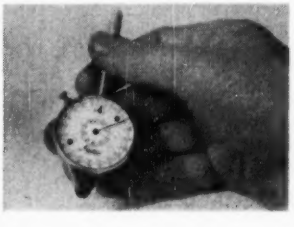


tank, to insure even wear of pumping units and eliminates evils of long standby for one pump. Additional function: starting second pump in cases where extra capacity under peak conditions is required.—*Square D Co., 4141 N. Richards St., Milwaukee 12, Wis.*

For more information circle **367** on inquiry card.

Blueprint Curvimeter

New "Minerva Curvimeter" ends difficulties of blueprint scaling; registers up to 2400 feet of straight or curved distances (exclusive "Minerva"



ALINA

KNURL CUTTERS

ALINA KNURL CUTTERS actually mill the pattern and produce chips in the process. Alina Knurl Cutters will cut your machining time approx. 30%. They will provide the solution to some of your most complex knurling problems.

DESIGNED TO

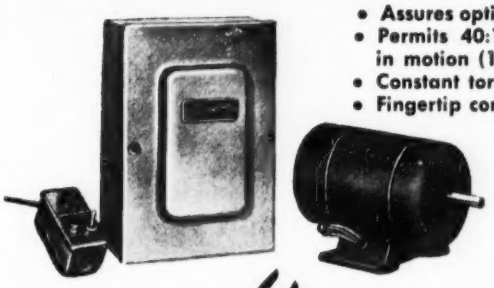
- knurl all machineable materials
- knurl thin-walled parts without internal support
- maintain fine diametral limits
- knurl diameters from 1/16" to 10 ft.

Models available for all types of machines.
For detailed information and prices, write to

ALINA CORPORATION • 401 Broadway, New York 13, N. Y.

For more information circle **84** on inquiry card.

VARIABLE SPEED CONTROL
STOCK DELIVERY



- Assures optimum process speed
- Permits 40:1 speed change while in motion (100 to 4000 rpm)
- Constant torque capability
- Fingertip control from remote point
- Electronic "SERVO" control
- ⅓ horsepower — 4000 rpm base speed — 115 volts and 230 volt models, 60 cycles

Uses: Coil winders, life test fixtures, proportioning pumps, printing presses, conveyers, small machine tools, etc.

MODEL 6301 FOR 230 VOLTS (WITH MOTOR) $149.50

MODEL 6701 FOR 115 VOLTS (WITH MOTOR) $159.50

OTHER MODELS AVAILABLE TO 3 HORSEPOWER

Servospeed DIV. of ELECTRO DEVICES, Inc.
4 Godwin Ave. Paterson, N. J.

For more information circle **85** on inquiry card.

Sorry . . .
A. W. HAYDON CO.
can't help you.

Only instruction, practice, and patience can improve your score!

But . . . if your problem is PRECISION TIMING

you may save time, trouble and money by investigating what our timing engineers have done for others. Our A.C. and D.C. achievements may already include the solution of your most complex problem. Why not find out?

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228 NORTH ELM STREET
WATERBURY 20, CONNECTICUT
Design and Manufacture of Electrical Timing Devices

For more information circle **86** on inquiry card.

Lightweight Tester Packs Heavyweight Punch

Model 640 Meg-Ohm Voltmeter features AC and DC ranges

Combines advantages of crank and vibrator type units.

Generator Output ....500 volts d.c.
Megohm Meter ....0-200 Megohms
Resistance .....0-2000 Ohms

Dimensions ....5¼" x 6⅞" x 2¼"
Instrument Weight .....2¼ pounds

Complete with test leads, bakelite case and instructions $74.95

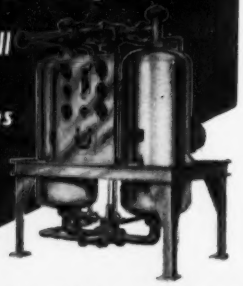
Single Meg-ohm Tester, similar to above, in 0-50 Meg-ohms. Priced at $35.00

HAZELTON INSTRUMENT CO.
128 Liberty St., New York 6, N. Y.

For more information circle **87** on inquiry card.

The Instrument Air Dryer

with all the features



★ Exclusive Finned System Desiccant Chambers
★ Automatic, Semi-Automatic, or Manual Control
★ Compact Functional Design (ASME Code)
★ Safety Interlock Control System
★ Atmospheric and Pressure Regeneration Circuits
★ Moisture Indicator and Instruments Panel Mounted
★ Superior Desiccant
★ Exit Dewpoint below minus 40°F at line pressure
★ Steam and Electric Reactivation

Submit your Dryer problems to our experienced instrument engineers.

SEND FOR Illustrated Bulletin

3170

Industrol CORPORATION

494 Westfield Avenue, East • Roselle Park, New Jersey

For more information circle **88** on inquiry card.

NEW INSTRUMENTS

feature). Three footage registers allow "Curvimeter" to record distances of up to 2400 ft. on blueprints scaled ⅛ in. to 1 ft.; 1200 ft. on prints scaled ¼ in. to 1 ft.; and 600 ft. on drawings scaled ½ in. to 1 ft. Error is prevented by totalizing "dial-within-the-dial."—*M. Ducommun Co., 580 Fifth Avenue, New York 36, N. Y.*

For more information circle **368** on inquiry card.

Combination Radio and Direction Finder

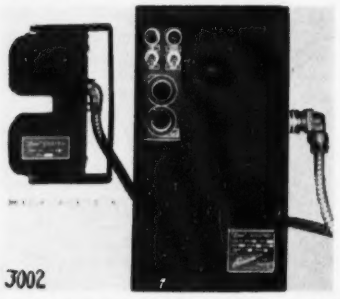
New "GM 114A" portable radio serves also as a marine direction finder to help boatsmen determine their positions at sea; receives "Marine" and

"Beacon" bands in addition to regular AM broadcast band. Instead of a radio loop rising from top, a flat, knob-like antenna projects only two inches above case. Boat owner may listen to his favorite program and, at the same time, rotate antenna until it points directly at radio station. He may also tune in "Marine" frequencies to locate vessels operating radiotelephones and to obtain weather information. "Beacon" band enables boat owner to make extremely accurate fixes and to locate light ships and danger points marked by government beacons.—*Raytheon Mfg. Co., Waltham 54, Mass.*

For more information circle **369** on inquiry card.

Photoelectric Edge Guider

New "Linar Edgetrol," for textile, paper, rubber and plastics industries has wide sensing-head slot and recessed control panel. Feature: no force

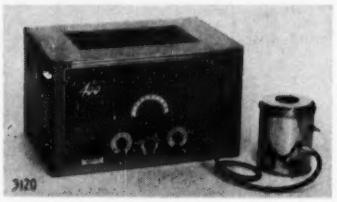


is applied on material, permitting edge registration of light or thin as well as heavy materials, even when not under tension. Rapid response results in over-all accuracy in 1/32-in. or better at high linear speeds at up to 60 actuations per minute. Can be used with standard tenter or other drives, either electric or hydraulic, up to 1 hp.—*Airlectron, Inc., P.O. Box 151, Caldwell, N. J.*

For more information circle **370** on inquiry card.

Ultrasonic Equipment

New "Model 400" wide-range 400-watt ultrasonic energy generator is announced, and with it a variety of transducers for production line or lab

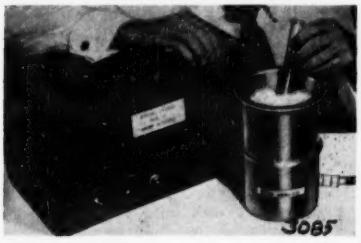


degreasing, emulsifying, etc., and for medical therapy and research. New generator is continuously tunable from 10 to 1200 kc. New types of piezoelectric and magnetostrictive transducers include new metal-jacketed and lined fully-enclosed water-cooled treatment chambers in which process materials are in contact with metal surfaces only; a new flanged flow-through chamber which can be bolted into a pipe line; and new expendable transducers for experimental purposes.—*Rich-Roth Labs., 1240 Main St., Hartford, Conn.*

For more information circle **371** on inquiry card.

Ultrasonic Generator

New "Model 50 Series Liquid Load Ultrasonic Generator" is both a new tool for parts cleaning and a laboratory instrument for ultrasonic experimentation. A barium titanate trans-

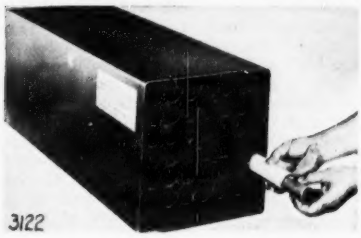


ducer, resonant at a frequency of about 1 Mc., driven by a 50-watt RF generator, radiates high-energy vibrations into a quart-size container of cleaning solvent or into a liquid sample in a test tube. Parts to 4-in. maximum dimension may be cleaned by immersion. Especially suited for ultrasonic cleaning are instrument movements and components.—*McKenna Labs., Santa Monica, Calif.*

For more information circle **372** on inquiry card.

Filing System

New "Multiroll File" is for large lay-outs and tracings; uses "mailing tube method"; makes material readily available through use of an index relating to coordinated tubes. A smaller tube is furnished with each file,



NEW

Advanced Design . . .

MODEL **DS-6100**

FREQUENCY COUNTER

All new electronic pulse indicator with a completely different circuitry approach that reduces size and weight without sacrificing accuracy. Direct read out in events per second to 100,000. Inherent accuracy is ± 1 event. Time base — 100 KC crystal controlled oscillator circuit. Easily portable and weighs only 28 pounds. Price — $675.00

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. . . lower power consumption allows continuous, accurate operation without excessive heat

Improved CIRCUITRY
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. . . advanced design offers ready portability

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. . . unit size reduced by unique design. Uses less bench space.

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Designed for portability and low cost as well as accuracy, this new Detectron unit will count and display electrical or mechanical events which can be converted to a varying voltage of sufficient amplitude. Direct read out in events per second to 10,000. Accuracy — approximately .1%. Weighs only 16 pounds. Price — $425.00

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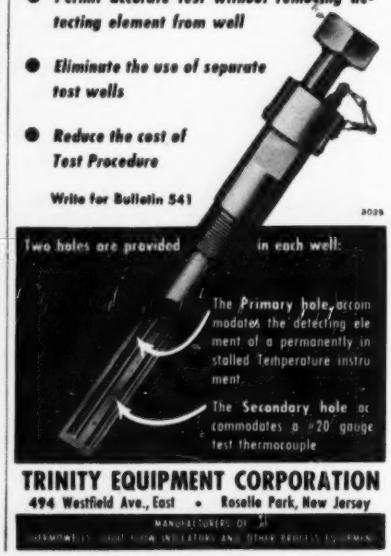
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For more information circle **92** on inquiry card.

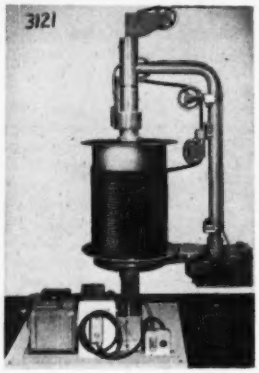
NEW INSTRUMENTS

around which material to be filed is first rolled. Rolling tube is later withdrawn. Three models, with tube lengths of 30, 36 and 42 in.—*Roll & File Systems, Inc., P. O. Box 85, Ferndale 20, Mich.*

For more information circle **373** on inquiry card.

Cable Reel

New "Connectoreel," on which any diameter of electrical cable can be wound without disconnecting cable ends or using slip rings or other



types of sliding contacts, is completely motorized, has a variable-speed drive and a level wind mechanism that is power driven and automatically reversible. It does not interfere with operation of test equipment that may be at either end of cable. It is available in either a horizontal or vertical model.—*Rodon, Inc., Neshaminy, Penna.*

For more information circle **374** on inquiry card.

Acceleration Pickup

New "Model RA-4" low-friction acceleration pickup has 0 to 4 *G* range, proportional within 2 percent, 300 ohms over-all resistance. Design permits power dissipation of 20 watts. Temperature range –67° F. to 160° F.; length 2½ in., diam. 1⅝ in.; weight 5 oz. Resistor is coaxially mounted with dashpot assembly, providing extremely low friction on sensitive axis. Owing to its unique design, unit can also be provided as a voltage divider resistor with single or multiple turn action or with linear action in any resistance range desired and with other *G* requirements.—*Ram Meter, Inc., 1100 Hilton Rd., Ferndale, Detroit 20, Mich.*

For more information circle **375** on inquiry card.

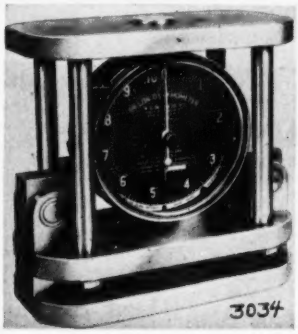
Projectile-timing Screen

New improved version of "Lumiline Screen," used in conjunction with oscillographs or chronometers, measures speed of projectiles such as bullets, golf balls, baseballs, rockets, etc. Two screens are set a known distance apart along path of projectile. A light source and a phototube provide first signal as projectile breaks light beam in first screen. When light beam in second screen is interrupted, second signal is transmitted to timing instrument.—*Industrial Instruments, Inc., 89 Commerce Rd., Cedar Grove, N. J.*

For more information circle **376** on inquiry card.

Load Cell

New "Pressure Cell" comprises a traction dynamometer mounted in a steel cage so that compressive loads

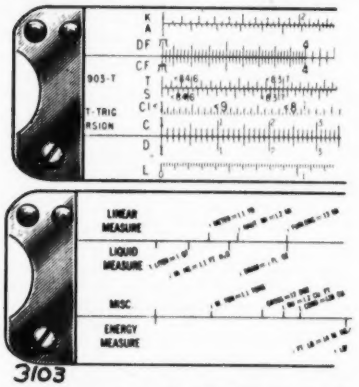


are indicated on 5-in. dial. Height 9.56 in.; weight 42 lbs.; available in seven capacities, from 0-250 to 0-10,000 lbs., each individually calibrated.—*W. C. Dillon & Co., Inc.*, 14620 *Keswick St., Van Nuys, Calif.*

For more information circle **377** on inquiry card.

Conversion Slide Rule

New "Model 903-T" bears 64 linear, liquid, energy and miscellaneous factors on one side plus a complete trig scale arrangement on reverse side

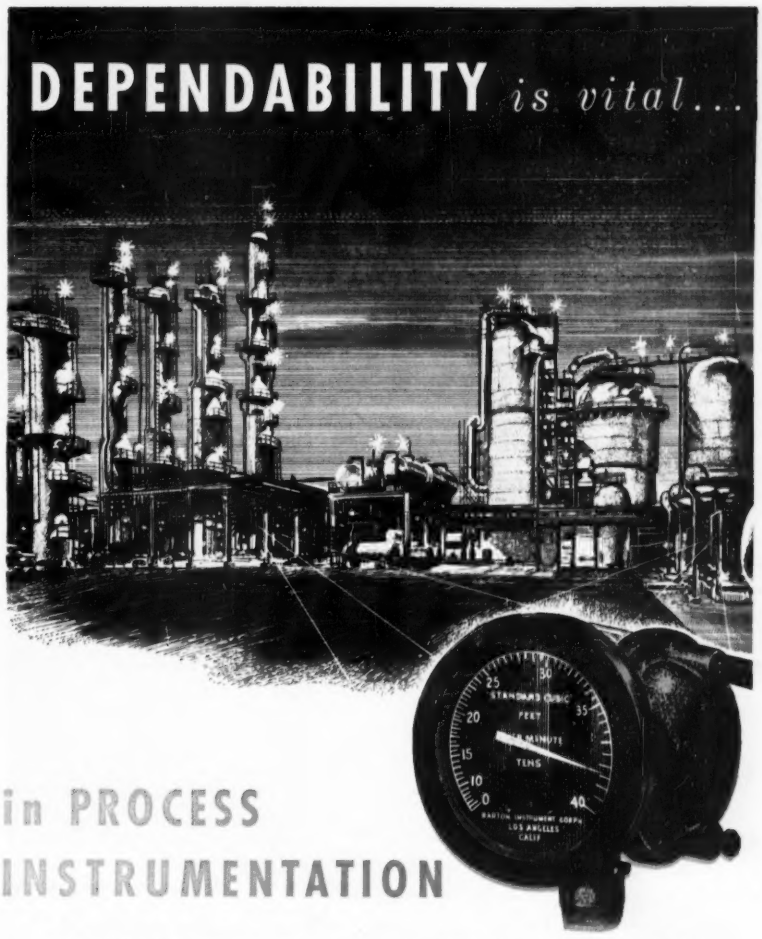


consisting of A, K, DF-CF, T, S, CI, C-D and L scales. By "positioning" a conversion mark opposite an index mark, any conversion is automatically set and read on C, D, CF or DF scales without moving slider. Length 12⅛ in. —*Pickett & Eckel, Inc.*, 1109 *S. Fremont St., Alhambra, Calif.*

For more information circle **378** on inquiry card.

Light Source

New "Synctron 223 Commercial and Industrial Speedlight," for black-and-white and color photography in industrial, commercial and studio applications, operates from 115-v.ac. Each power supply makes provision for two lights and any number of additional power supplies and lights can be operated by means of photocells so that, when any one unit is fired, all others operate in synchronism. Each light source contains focussing light available in 50, 100, 150, and 200-watt sizes matching output of flash tube. Color guide number is 110 (previously available only in units weighing 100 lbs. or more and costing three to four times as much). Power range from



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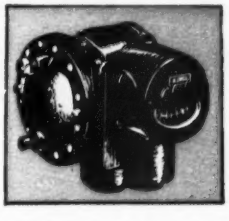

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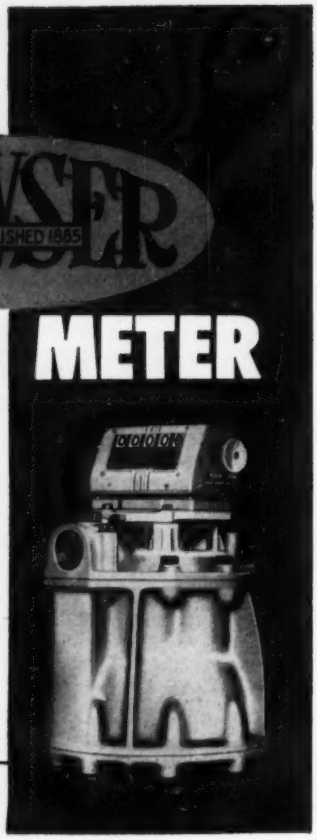

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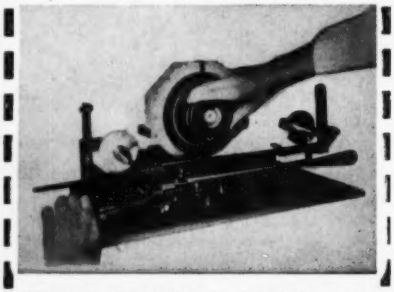

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For more information circle **96** on inquiry card.

NEW INSTRUMENTS

100 to 400 watt-seconds per light.—*Dormitzer Electric & Mfg. Co., Inc., 5 Hadley St., Cambridge, Mass.*

For more information circle **379** on inquiry card.

Variable-power Transit Eyepiece

New "Variable Power" eyepiece, obviating need for more than one eyepiece for changes in magnification, is now standard on maker's transits. It is not necessary to refocus objective when using new eyepiece.—*W. & L. E. Gurley, Troy, N. Y.*

For more information circle **380** on inquiry card.

Relay Panel for Cooking Classroom Protection

New special "Asco Control" was designed specifically for use in cooking schools, restaurants, institutions, etc., where gas-fired equipment is being used. Its purpose is to automatically shut off flow of gas to ovens, broilers, etc., should electric power fail or drop below a minimum voltage level. It is particularly useful in installations where quiet operation is essential.—*Automatic Switch Co.*, 391 *Lakeside Ave., Orange, N. J.*

For more information circle **381** on inquiry card.

Conelrad Alarm

New "Weins Conelrad Alarm" attaches readily to any radio receiver; will give a visual indication whenever radio station goes through required FCC radio alert procedure. In addition, audio volume of station, in case of loudspeaker muting, will automatically come up to full audio output and radio tone signal will serve as a second alarm indication. Alarm is designed to operate on 1000-cps. tone signal to indicate a radio alarm (Yellow Signal); utilizes avc. voltage produced in receiver by broadcast station. —*Trinity Industries, P. O. Box* 71, *Redwood City, Calif.*

For more information circle **382** on inquiry card.

Moisture Trap

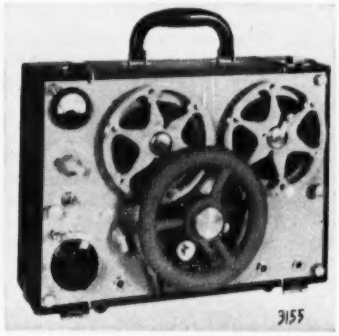
New "No. 81" float-type trap drains moisture and condensate continuously

and automatically from equipment handling air, gas or steam, at pressures up to 200 psig.—*The V. D. Anderson Co.*, 1935 *West 96th St., Cleveland 2, Ohio.*

For more information circle **383** on inquiry card.

Portable Tape Recorder

New "Multiple Speed VU Magnemite Battery-operated Spring-motor Portable Tape Recorder" incorporates a VU meter to act as recording-level indicator, output level indicator and



"A" and "B" battery indicator. One-, two-, three- and four-speed models are available utilizing consecutive speeds from 15/16 ips. to 15 ips. Equalization for different speeds is automatic.—*Magnemite Div., Amplifier Corp. of America, 398 Broadway, New York 13, N. Y.*

For more information circle **384** on inquiry card.

Synchronized Streak Camera

New control facilities (illustrated, right) make "Model 168 Streak Camera" a complete system for synchronized recording of position-versus-time data: it makes a plot on 4x10-in. film where vertical axis represents space and horizontal axis represents time. An external objective lens images

event on camera slit (visible, left); an internal lens forms an inverted, approximately 1-to-1 image of slit on face of a polished steel rotatable mirror. When mirror is being driven at max. speed of 50,000 rpm., image is swept across film at a writing rate of 5.46 mm. per usec. and film-length writing time of 44 usec.—*Beckman & Whitley, Inc., 1096 E. San Carlos Ave., San Carlos, Calif.*

For more information circle **385** on inquiry card.

35-mm. Printer

New "Colorcontact," for duplicating on both B&W film or paper and color film, holds up to 90 ft. of original film and 30 ft. of unexposed film or paper. Automatic blind allows use of same lightsource for negative inspection and printing.—*Karl Heitz Inc., 150 W. 54th St., New York 19, N. Y.*

For more information circle **386** on inquiry card.

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For more information circle 98 on inquiry card.

Events...

Instruments and AUTOMATION

October 28-30

International Symposium on Temperature, at Washington, D.C. Joint sponsors: American Institute of Physics, National Bureau of Standards, U.S. Army. For information write Wallace Waterfall, A.I.P., 57 E. 55th St., New York 22.

November 3-5

Joint Meeting of Twelth Annual Pittsburgh Diffraction Conference and American Crystallographic Association, Mellon Institute, Pittsburgh, Pa. For information contact P. K. Koh, Allegheny Ludlum Research Laboratories, Alabama Ave., Brackenridge, Penna.

November 4-5

East Coast Conference on Airborne and Navigational Electronics, sponsored by the Baltimore Section of the IRE and the IRE Professional Group on Aeronautical and Navigational Electronics will be held at the Sheraton-Belvedere Hotel in Baltimore. For information write G. R. White, Bendix Radio Div., Bendix Aviation Corp., Towson 4, Maryland.

November 10-11

Conference on Electronic Instrumentation and Nucleonics in Medicine, Morrison Hotel, Chicago. For information write R. S. Gardner, A.I.E.E., 29 W. 39th St., New York City.

November 12-13

National Symposium on Quality Control and Reliability in Electronics, sponsored by the Professional Group on Quality Control of the IRE and the Electronic Technical Committee of the ASQC will be held at the Statler Hotel, New York City. For information contact either sponsor.

November 18-19

Sixth Annual Electronics Conference, sponsored by Kansas City Section of IRE will be held at Hotel President, Kansas City. For information write Robert W. Butler, P.O. Box 8857, Kansas City, Missouri.

November 18-19

Eighth Annual Midwestern meeting of Society of Exploration Geophysicists will be held at the Adolphus Hotel, Dallas, Texas. For information contact Society Headquarters, 624 S. Cheyenne, Tulsa, Oklahoma.

November 21-22

Automatic Control Equipment Exhibition, Waldorf-Astoria Hotel, New York City.

November 29—December 2

First International Automation Exposition and Computer Clinic, at the 244th Coast Artillery Armory, New York City, N. Y. For information write First International Automation Exposition, 845 Ridge Ave., Pittsburgh 12, Pa.

December 8-10

Eastern Joint Computer Conference and Exhibition will be held at Bellevue-Stratford Hotel, Philadelphia. For information write Computer Conference and Exposition, P.O. Box 7825, Phila. 1, Penna.

February 28-March 4, 1955

Sixth Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, William Penn Hotel, Pittsburgh. For information write J. F. Miller, Mellon Institute, 4400 Fifth Ave., Pittsburgh 13, Penna.

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Plastic vs. Metal Tubing

The pioneer user of polyethylene tubing reports on the developments made and the savings possible. Cooperation between user, tubing manufacturer, and plastics manufacturer has made possible a revolutionary development of extreme importance to every instrument department. This report is the culmination of ten years of experimentation and close cooperation between user and manufacturer.

by E. I. THOMAS
Carbide and Carbon Chemicals Company

Background of Field

VARIETY of plastics available in the early 40's was limited and, during the war years when metal tubing was scarce, attempts to use plastics for instrument air tubing were not successful. However, with the availability of new plastics, the suppliers of these materials have proven that, when correctly applied, plastic can be used for instrument tubing successfully and profitably. The suppliers, working first with the instrument user and then with the plastic industry, were successful in developing a product for the exacting requirements of the chemical industry.

1944 saw the first plastic extruded over copper and steel tubing by the Dekoron process to protect the metal from severe corrosive atmospheres prevalent in the chemical industry. This tubing was installed where other metals —copper, aluminum, steel, stainless steel, etc.—failed to last longer than six months. One installation of this type is still in service and performing perfectly. Not only did the plastic-coated metal tubing cost less to buy and less to install than metal alloys, but its life thus far is approximately sixteen times that of the material it replaced—and there is no failure in sight. After the success of this installation, suppliers became more active in the field of instrumentation, and pressure was brought to bear on them to bring out an all-plastic instrument tubing.

Presented before the ASME, Chicago, F bruary 16, 1954.

Experiments with several types of plastics followed, and polyethylene was eventually chosen; ¼-inch-O.D. by 0.040-inch-wall polyethylene tubing was chosen as a standard size because it allows a flow closely approaching that of ¼-inch-O.D. by 0.030-inch-wall copper tubing, and its wall strength is more than adequate for the application. The bursting pressure of the tubing depends not only on the thickness of the wall but also on the quality of the plastic; thus, it is important that only virgin materials be used and that the tubing be free of pin holes and holidays. Several grades of polyethylene tubing are available for specific uses. However, only material of specific instrument quality should be used for instrument-air tubing.

Initial Use

In the mid 40's we had a problem. We had to keep a unit in operation where atmospheric conditions corroded through the instrument air lines in less than six months, even though they were 316 stainless steel. To solve this problem, steel tubing with 1/16-inch "Vinylite" plastic extruded on the outside was developed. Approximately 8 years later this initial installation is still intact; a portion of it is shown in Fig. 3.

After this installation had proved superior to others, we had instrument manufacturers use the same technique and apply plastic for protection of the flexible armor of thermal systems. Accumulations of deposits, including fly ash,

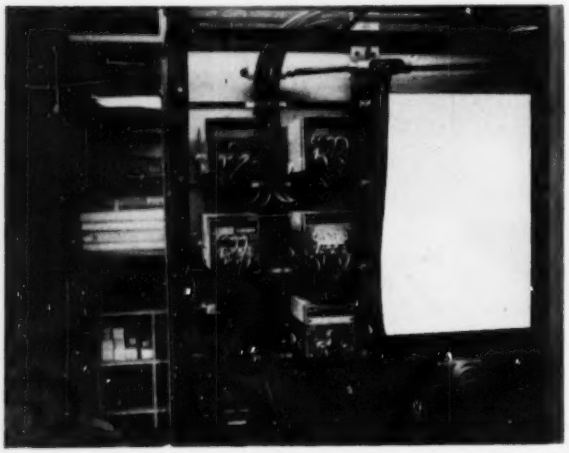

Fig. 1. Experimental test panel showing instruments tubed with polyethylene (also see front cover).

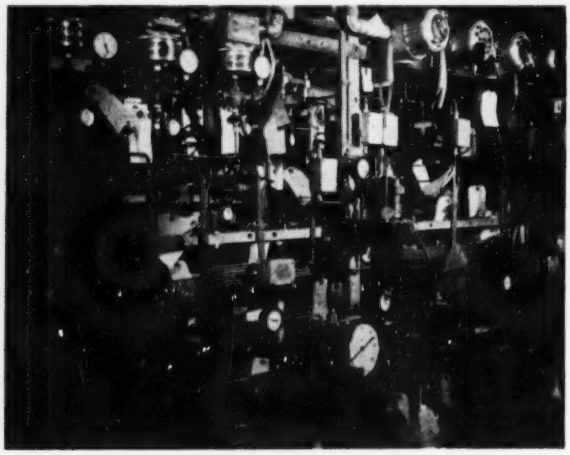

Fig. 2. Instruments tubed with metal tubing.

For Instrument Air Service

Table 1.—Costs of instruments and metal-tubing installations in 1934, 1941, and 1947.

Date	Total Number Insts. Installed for one Unit	Inst. Costs; (% of Major Equip. Costs) Mat'l.	Labor	Total	Labor Costs for Installing Insts. (% of Mat'l. Costs)	Av'g. Cost per Inst. (dollars) Mat'l.	Labor	Total
1934	86	7.2	1.7	8.9	23.8	273	86	359
1941	82	6.4	3.3	9.7	51.6	424	290	714
1947	63	24.1	19.4	43.5	80.6	667	587	1254

within the convolutions of the armor would gather moisture causing an acid condition that resulted in system failure. These companies started furnishing thermal systems with plastic protection by 1946; today these failures are barely one-tenth of what they were.

Late in 1945 we started an Instrumentation Engineering Test Laboratory to evaluate new instrument items and to develop better installation methods. Considerable time was spent piping the instruments for different tests, and it became evident that this program would bog down simply because of the piping requirements. To expedite the tests we resorted to the use of fabric-reinforced-rubber air lines with "quick-connect" fittings. Difficulties in installing these fittings and their large size and cost led us to seek other types of tubing. Polyethylene proved to be best after we had developed a suitable fitting.

Cost Analysis

Test installations of polyethylene tubing, together with a cost analysis for plants constructed with conventional metal tubing during the years of 1934 to 1947, served as an added incentive to further the use of this material. Cost figures (see Table 1) revealed that material costs (average cost per instrument) increased approximately 2½ times while labor costs for installing instruments increased almost 7 times.

One of the first plastic installations came about in this way. A chemical unit was scheduled for production, and last-minute changes to the process required repiping two identical instrument panels. Two men spent three days repiping one of these panels using conventional metal tubing, but, because of the urgency of starting the unit, it was decided to use polyethylene tubing for the second panel. This was done by one man in less than one hour. We got production started at least two days sooner.

The metal tubing, although much neater, was a much costlier job. Cost analyses for this unit revealed that labor for installing the metal tubing was $2.10 per foot.

In March 1952 we considered the use of plastic-covered copper and/or aluminum tubing in lengths of 500 or 1,000 feet. We figured that if we could obtain the material in long lengths, the installation costs would be reduced by installing supporting troughs for the tubing. At this time, having in mind the bundled plastic tubing used in the laboratory, we suggested to the company which has been our supplier of plastic-covered metal tubing, that they try to manufacture bundles of polyethylene tubing for instrument air service, hoping in this way to overcome high in-

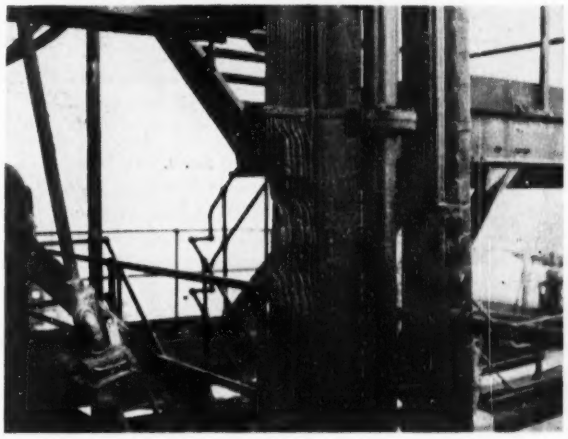

Fig. 3. Plant installation of plastic-protected metal tubing with eight-years' service.

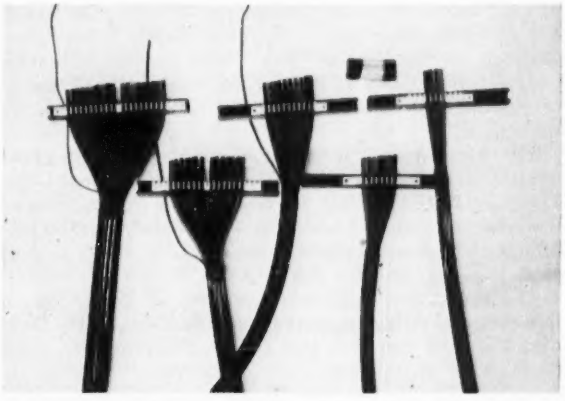

Fig. 4. Commercially available polyethylene-tube bundles (Dekoron "Impervak Poly-Cor"). Small bundle at top right is originally suggested grouping.

Fig. 5. Use of multitube cable and trough for supporting tubing bundles.

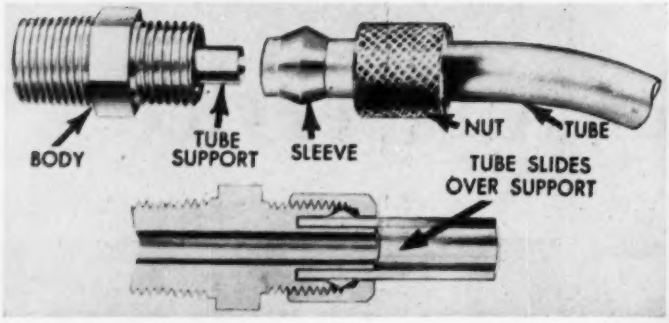

Fig. 6. Fittings developed for use with polyethylene tubing.

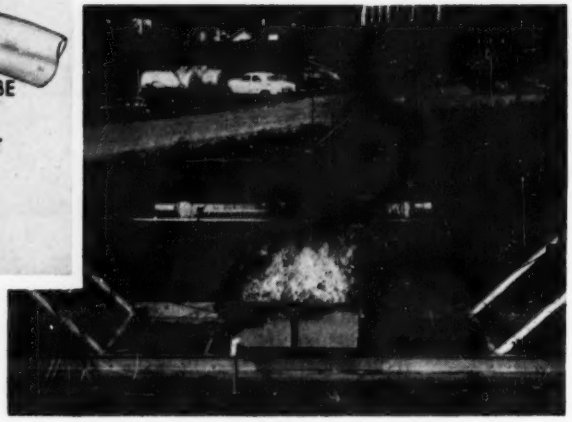

Fig. 7. Fire exposure scene.

high installation costs. To demonstrate our suggestion, we taped together nineteen small lengths of polyethylene tubing. This original sample—about the size of a package of cigarettes—can be seen in the upper right-hand corner of Fig. 4. Also shown are samples of bundles of multitube cable that are available today.

Fig. 5 shows the use of this multitube cable which replaced the single-tube laboratory installation for weather tests. It also shows the use of a trough for supporting the tubing. The trough and fittings are of expanded metal, heavily galvanized and rolled flat before forming to eliminate all sharp edges. This trough prevents the accumulation of fly ash and dirt and offers a practical method of support for multicore plastic tubing for instrument installations.

The compactness of using plastic tubing instead of metal is not as important as is the savings in labor costs. There are available metal tube bundles that can be installed the same way but at a much higher cost than polyethylene tubing. A cost comparison for material per 100 foot of cable is shown in Table 2.

The installation labor cost per foot of copper tubing in a chemical unit completed in late 1952 was $2.10. Compare this with the labor cost for installing conduit, junction boxes, polyethylene tubing, and connecting the instruments for the last unit installed in 1954. A total of 160-hours' time was required; if we use a labor charge of $5.00 per hour plus 100 percent for contingencies, the cost of this installation was 14½ cents per foot of tubing.

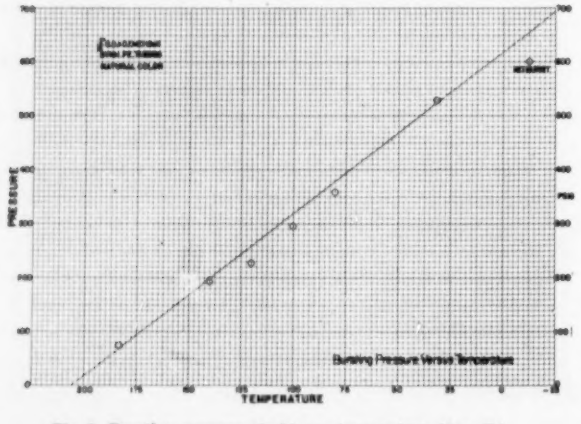

Fig 8. Bursting pressure (psi.) vs. temperature (deg. F.).

Fittings

At first we attempted to use compression-type fittings and metal ferrules with polyethylene tubing. However, the ferrules (sleeves) cocked and frequently caused leaks. Special fittings were developed with ferrules molded from polyethylene and of the same general design as metal ferrules. These fittings (Fig. 6) are now available from Samuel Moore and Company (the Dekoron "E-Z" tube fitting) and from the Imperial Brass Manufacturing Company (the "Poly-Flo" tube fitting).

With these fittings (having the inner tube support and the plastic ferrule) only finger-tight, pressures from 29 in. of Hg vacuum to over 600 psi. can be held. Pressures as low as 10^{-4} micron can be sealed if glass tubing is substituted for the plastic.

Bursting Pressure vs. Temperature

Tests were made to determine the suitability of the plastic tubing at temperatures as low as minus 20 F. and as high as 175 F.

Six samples of tubing, in a manifold, were tested in a temperature chamber. Natural-color polyethylene tubing of medium molecular weight and ¼-inch-O.D. by 0.040-inch wall was used for these tests; all tubing connections were made finger-tight. The temperature was changed slowly to permit the test samples to be at a uniform temperature. After a selected temperature was obtained, nitrogen pressure was applied slowly to the manifold until a rupture occurred. Random samples of colored polyethylene tubing were tested to determine if there would be any difference in bursting pressure due to the color additive. The results were the same for both tests.

Table 2.—Cost comparisons (in dollars) for 100 feet of tubing.

Number Tubes per Bundle	*¼" O.D. Copper 0.030" Wall Price /100'/* 5000 8/53 (A)	*¼" O.D. Aluminum 0.032" Wall Price /100'/* 5000 (A)	*¼" O.D. Polyethylene 0.040" Wall Price /100'/* *5000 1/53
4	87.60	65.00	29.44
7	126.50	92.40	46.60
8	143.50	104.00	
10	179.00	127.30	60.29
12	205.00	143.00	
14			74.73
19	309.00	214.00	90.98

*Telephone wires add $3.00/100 ft. for 10-, 14-, and 19-tube cables.
(A) Flexible galvanized armor overall.

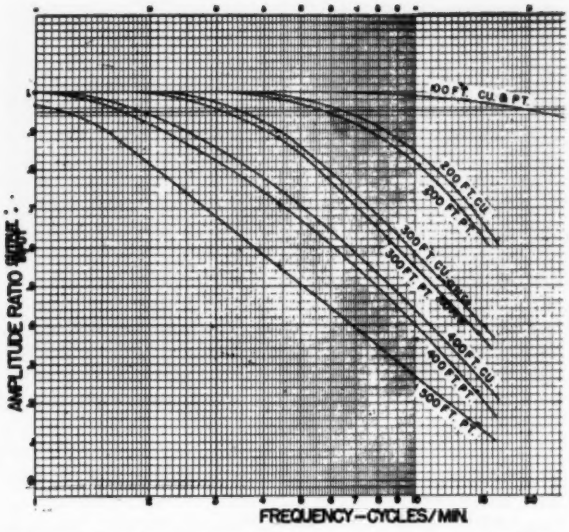

Fig. 9. Attenuation of sinusoidal signals in copper and polyethylene tubing (PT).

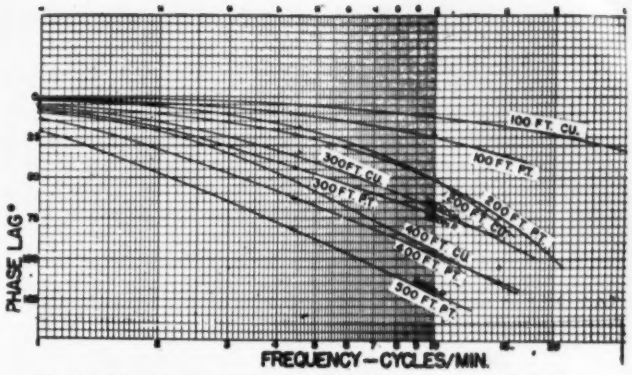

Fig. 10. Phase lag versus frequency of signal for copper (CU) and polyethylene tubing (PT).

Fig. 8 shows the results. At a temperature of minus 12½ F., the tubing did not burst with a pressure of 600 psig.; at 175 F. the bursting pressure was 90 psig. For normal instrument air service of 20 psig. the factors of safety are adequate.

Fire Resistance

Polyethylene burns like a candle; this concerned our Process Safety and Fire Protection Department. Extensive fire tests were made for fire-protection purposes.

The test set-up consisted of a tube support over a fire pan approximately 4x8 feet by 16 inches deep (Fig. 7). Gasoline over a water surface was used as fuel.

Three separate tests were made. In the first test (considered ideal for plant fire-protection conditions) a water spray was turned on at the time the fire was ignited. This test proved that water spray did not afford adequate protection for the tubing. The second test was made to evaluate different types of tube supports. The third test was a supplementary one under laboratory conditions to verify some of the results of the first two tests.

In the first test, different types of metal tubing as well as polyethylene were subjected to the fire. The plastic multitube cables were supported in the open expanded-metal trough. Clamped to the outside of this trough were samples of copper, aluminum and stainless-steel tubing. Tube supports of bare iron conduit and Transite pipe also were fire exposed. Even with the water-spray protection, a failure of polyethylene tubing occurred in one minute and fifteen seconds; the aluminum tubing failed in two minutes and fifteen seconds. After five minutes a flame temperature of 1450 F. was reached. As a result of this test it was concluded that plastic, aluminum or copper tubing, if exposed to severe fire conditions, do not give uninterrupted instrument service for more than a few minutes.

In the *second fire test* we used conduit to support and protect the polyethylene tubing. The test specimens were (1) bare iron conduit with single-strand polyethylene tubing inside and (2) conduit having two types of insulation, one with single-strand polyethylene and the other with both single-tube and multitube polyethylene cables. At a surprisingly short time of 1 minute and 40 seconds, the single-conductor cable inside the insulated conduit that also supported the multitube sample failed. The multitube 10-conductor cable did not have a single tube failure until fire exposed for 20 minutes and 40 seconds.

The tubing was removed and examined. The multitube cable did not appear damaged. The single tube had failed at two points that corresponded to the location where the conduit had been resting on the edges of the fire pan. There was some damage to the insulation at the points of tube failure. We concluded that, due to mechanical damage to the insulation, the single-tube polyethylene cable was caused to fail by contact with hot spots of the conduit. Table 3 summarizes these tests.

Further laboratory tests proved that the "Vinylite"-sheathed cable has approximately 50-percent greater resistance to failure due to fire or heat than does unsheathed single-conductor polyethylene. The tubing used for these tests was taken from one piece of multitube cable, single tubes being obtained by stripping off the vinyl sheath. It was concluded from these tests that:

1. Any duct with fire resistance equal to that of insulated iron conduit would provide not only adequate protection for multiconductor vinyl-sheath polyethylene tubing, but would afford longer instrument service during fire exposure than with exposed metal tubing.
2. Vinyl-sheath multiconductor cable should be used instead of single-strand tubing.

Speed of Response

Many instrument users today are concerned with the speed of response of control systems. We made tests to compare the response of signals in copper tubing of ¼-inch-O.D. by 0.030-inch wall thickness, polyethylene tubing of the same outside diameter but with 0.040-inch wall thickness, and also with 0.062-inch wall thickness. Pressure drop for a given flow of air through different lengths of copper tubing was plotted. For 100 feet of tubing and a flow of 50 cubic feet per hour, a pressure loss of 4 pounds is required for copper tubing. For 100 feet and 50 cubic feet per hour flow for 0.040-inch-wall polyethylene tubing we have a pressure loss of 6.25 pounds. For 0.062-inch-wall polyethylene tubing, with 96 feet of tubing and a flow of 50 cubic feet per hour, a pressure loss of 21.5 pounds occurs.

Further tests compared ¼-inch-O.D. by 0.030-inch-wall copper tubing with ¼-inch-O.D. by 0.040-inch-wall polyethylene tubing. Oscillatory signals transmitted through the tubing were observed for distortion and loss of amplitude in different transmission-line lengths. For frequencies of 10 cycles per minute and above, the loss in amplitude is not significantly different for the two types of tubing.

Fig. 9 compares these tubes when a sinusoidal disturbance of 9 pounds ± 3 pounds is applied at the inlet at

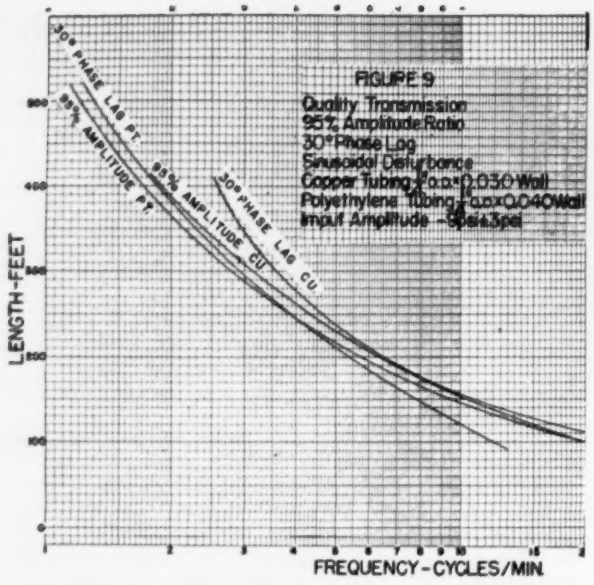

Fig. 11. Quality transmission curves for copper and polyethylene tubing.

different frequencies. Data were plotted as amplitude ratio versus frequency (cycles per minute). Amplitude ratio is obtained by dividing the output by the input value, and plotting for different lengths of tubing. The curves show that there is not great difference in the response characteristics of copper and polyethylene. If there had not been 0.010-inch difference in the wall thickness, we are of the opinion that polyethylene would show a slightly greater resistance to flow than new copper. However, for an old installation (after the copper tubing has become somewhat tarnished) we are not sure that there would be any difference between these response characteristics.

Fig. 10 is a comparison of these tubes when plotting phase lag versus frequency. Here copper tubing shows slightly better results than polyethylene.

Quality of Transmission

Fig. 11 is a comparison of tubes as to quality of transmission. A portion of the frequency-response data has been replotted as quality transmission curves. These curves give the maximum permissible length of tubing for a given response to a known-frequency signal. Quality transmission is defined as no more than 5-percent change in fundamental amplitude, or more than plus or minus 30 degrees phase shift—whichever is more stringent. The curves show that polyethylene tubing has a slightly lower transmission quality than copper tubing of the same length. This is probably due to the smaller I.D. of the polyethylene. We are now preparing to do additional work in this field to obtain more accurate data over a wider variation of frequency ranges.

Table 3.—Results of Fire Test

Type of Installation Tested	*Time of Failure Single-cond. Polyethylene (min.)*	*Time of Failure Multi-cond. Polyethylene (min.)*
Iron conduit, uninsulated, no water spray	.33	—
Open expanded-metal trough with water spray	—	1.25
Iron conduit, uninsulated, with water spray	—	2.58
Iron conduit, insulated with 1-in. Unibestos, ⅛-in. Insulmastic weather-proofing	5.25	—
Iron conduit, insulated with 1-in. Kaylo, ⅛-in. Insul-Kote weather-proofing	1.67	20.67 (1 cond. failed. No other cond. failed for 40 min.)

Fig. 12. Use of junction boxes and multitube cable.

Pulling Cable

The ease with which the multitube vinyl-sheath cable can be pulled in conduit is an important feature. This vinyl sheath also protects the individual tubes from abrasions and collapses which have occurred when using single tubes.

Resistance to Impact

A rather crude experiment was made to show what would happen if some object accidentally struck metal and plastic tubing. A sixteen-pound flange was dropped a distance of 30 inches, striking a piece of aluminum tubing, one of copper, and one of polyethylene. The metal tubes were flattened by 1/32 of an inch. The resilient polyethylene tubing was not damaged.

Installation Factors

As shown in Fig. 1 (and on the front cover of this issue), the neatness of this tubing installation and its flexibility surpass panels using metal tubing. This has been done by utilizing proper clamps and supporting means that were developed in conjunction with this project.

Table 4.—Weight Armored Metal and Sheathed Plastic Tubing.

Number Tubes per Bundle	*Weight per 100 ft. in Pounds*		
	Copper	*Aluminum*	*Polyethylene*
4	66	44	9
7	97	58	16
8	110	66	
10	133	77	20.6
12	152	84	
14			25
19	220	113	30.4

Use of junction boxes and the multitube cable is shown in Fig. 12. The 10-, 14- and 19-tube bundles have within them a pair of polyethylene-covered wires. These wires are connected to phone jacks at the panel and within the junction boxes so that sound-powered telephones can be used for initial tracing of leads and for trouble shooting.

Fig. 13 shows that it is practical to start with multitube bundles of the maximum number of tubes from the instruments in the control room to the junction boxes in the structure. At these junction boxes, the tubing can be connected in several combinations to utilize tube bundles having smaller numbers of tubes. These smaller tube bundles are then extended to other junction boxes. This system gives good flexibility and economic use of the polyethylene tubing. From the most remote junction box, we resort to plastic-covered copper tubing for connecting to the instrument items. Ten to 20 feet usually covers the length of metal tubing used in making the final connection. This metal tubing is used only because it is easier to support than individual strands of polyethylene.

Fig. 14 shows the tube rack at the top of the instrument panel and the multitube cables that will connect to remote junction boxes.

Fig. 15 shows the conduit and a junction box. For this installation the main conduit from the panelboard to the junction box was four inches in size and had four 19-tube, one 14-tube, and one 10-tube bundle, a total of 100 individual tubes. Compare this with the all-metal-tube installation shown in Fig. 16, which has 96 tubes in the vertical plane at the left.

Table 4 compares the weight of armored-metal and sheathed plastic tubing.

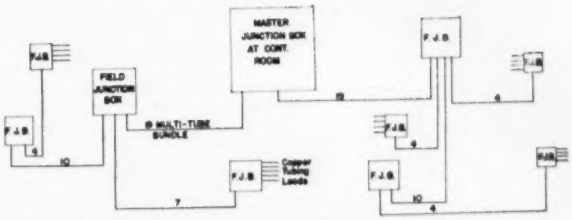

Fig. 13. Use of master and field junction boxes.

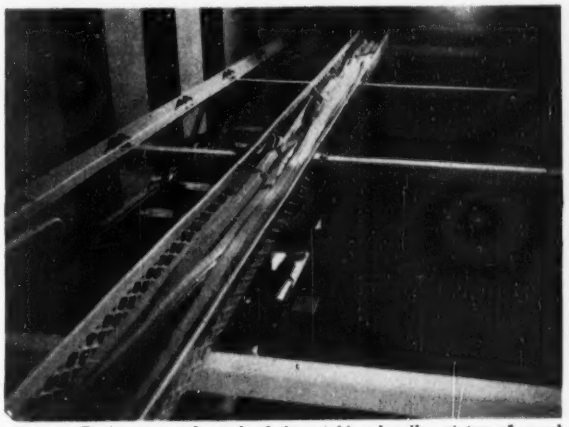

Fig. 14. Rack support for polyethylene tubing bundles at top of panel board.

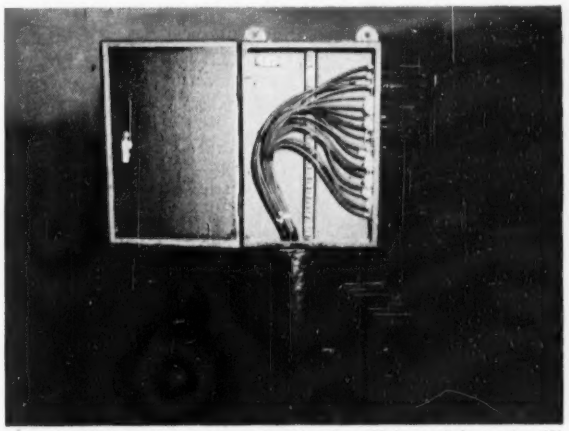

Fig. 15. Main conduit and one junction box. Main conduit carries 100 individual tubes.

Fig. 16. All-metal-tube installation with 96 tubes at left.

Summary

Polyethylene multitube cable used for instrument air service will decrease the installation time and labor costs, and provide a more flexible over-all installation than can be obtained with metal tubing.

This tubing can be installed in a number of ways: as wire cable from one support bracket to another; in expanded metal trough; in trenches, buried, or in conduit.

Insulated conduit used as a support for the polyethylene multitube cable will give longer instrument service than can be expected from exposed metal tubing during fire exposures.

Longer lengths can be installed than is possible with metal, thus eliminating joints. It is lighter to handle and can be installed with smaller-radius bends.

The use of the vinyl sheath over the tubing bundles increases resistance to tear and abrasion and affords additional fire protection.

Polyethylene cable decreases cost of tubing maintenance because the only tools required to install or repair are a sharp knife, a 6-inch Crescent wrench to install the tube adaptors, and a good thumb and forefinger to make the fittings finger-tight.

Corrosion by chemical-plant atmospheres is no longer a problem because any exposed polyethylene is resistant to most chemicals.

The use of sound-powered telephone wires within the large tube bundles will aid in expediting instrument checking during the years to follow.

Claims have been made that electrically-operated instruments can be installed cheaper than pneumatic ones. It is our belief, however, that, if polyethylene tubing is used for "tubing" pneumatically-operated instruments, a less costly and more versatile installation will result.

The Automatic Factory—
A Critical Examination

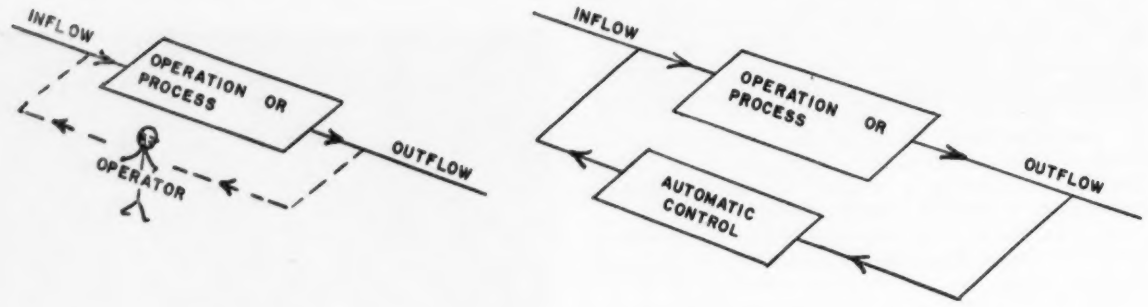

Fig. 3-1. Open-loop (left) and closed-loop (right) control systems.

Part III

Mechanization Vs. the Automatic Factory

Growth of Mechanization

THERE are many reasons why businessmen have constantly increased mechanization in their factories: to reduce costs, to meet and surpass competitors' methods of production, to satisfy increasing consumer demand, to counter insufficient availability of labor, to improve the quality and design of products, and to make use of new materials and production techniques.

The desire to achieve greater mechanization of production has been satisfied partially by the development of specialized machines, the use of improved materials-handling equipment, new methods of manufacturing, and instrumentation. Until now it has been through these channels that industry has made great strides in replacing manual with mechanical operations.

However, in discussing manufacturing it must be realized that there are two functions involved. One is manual —that is, driving nails and pushing levers. The other is mental—that is, determining which nail to drive and which lever to push. Practically all the progress in making manufacturing more automatic has been in the area of substituting mechanical operation for manual operation. Or, as some people phrase it, "substituting machine power for manpower." However, until the last few years, little had been accomplished in replacing the human *mental* function (substituting "mechanical brain power for human brain power").

There are several reasons why this was so. First of all, until the manual operations of a process are replaced by some mechanical device, no substitution for the mental function of the worker can be made. Secondly, the technology of replacing the mental function was practically unknown until 15 years ago. Even today, the surface is just being scratched, despite the tremendous advances made in World War II.

The majority of work done recently in connection with the mental function has not been to replace but rather to supplement it. This has been accomplished by increased use of instrumentation. By attaching significant instruments to processes, workers are given more and better information concerning operations. This enables the human brain to be employed in a more rapid and efficient manner.

The replacement of the mental function *entirely* is the latest advance in the field of automatic operations. It is only when this is accomplished that the fully automatic factory can be realized.

With the above conception of what the automatic factory would entail, several questions are raised. Why is such a degree of automatic operations needed? What are the elements required in the completely automatic factory?

Why Complete Automaticity?

All the reasons stated previously as goals of mechanization are also goals of completely automatic operation. However, in addition to these goals, other factors make complete automaticity desirable. As machine speeds increase, and as machine operations become more complex, operators can not keep up mentally with the demands of the machines. Other products, such as radioactive materials and explosives, cannot be controlled by operators

Prepared for General Georges F. Doriot in partial fulfillment of the requirements of the manufacturing course at the Harvard Graduate School of Business Administration.

Replacement of the mental function entirely is the latest advance in the field of automatic operations . . . . but computers cannot think. The computer can replace the mental function only if the process variables can be predicted and expressed mathematically.

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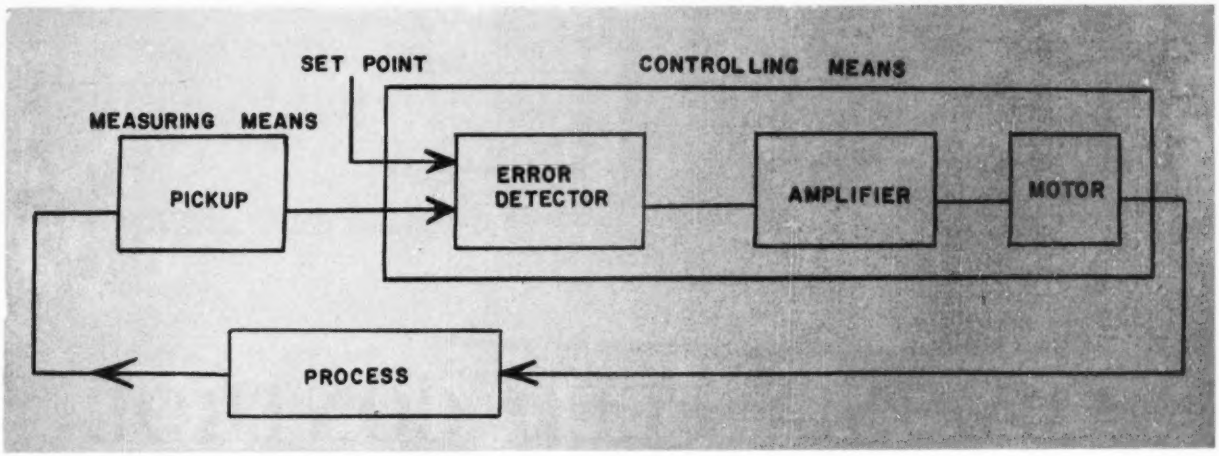


Fig. 3-2. Components of a closed-loop control system.

because of the physical danger involved. In producing these products, as well as when working conditions are adverse, completely automatic controlling mechanisms have been developed to replace workers.

Elements of an Automatic Factory

Automatic controls will replace the human mental functions in the automatic factory. There are two types of controls—open loop and closed loop (Fig. 3-1).

If the function of controlling a process is not completely automatic, so that an operator must adjust the process, the operation has an open-loop control. If, for example, an operator controls the level of a liquid in a tank by visual inspection and subsequent adjustment, he is performing as part of the control device.

In a closed-loop system a completely automatic controlling device replaces the operator. The device fills the gap represented by the worker in the open-loop system.

The operation of a closed-loop automatic-control system is shown in Fig. 3-2. A primary element (sensor or pickup) measures the variable to be controlled—temperature, speed, size, weight, composition, or any other process variable.

An error-measuring device receives the information from the pickup and compares it to preset information from a "memory." The deviation between the reference point (set point) and the variable determines if the process is operating properly and what, if any, adjustment might be needed to restore it to the preset control point.

In a complex process, the determination of whether the process is operating properly may be carried out by applying the information from the pickup and memory unit to a mathematical formula set up in the controller. Here computers could be used in conjunction with the differential error detector. If, however, there is only one process variable to consider (such as temperature) the use of a mathematical formula is unnecessary and a conventional control device can be used.

The error signal from the differential error detector is then sent to an effector (final control element) which changes the material or energy input to the processing unit. The effector receives the signal and amplifies it to enable its servomotor to make the change in the processing machinery.

A simple familiar example of a closed-loop controller is the household furnace thermostat. The temperature-sensitive bimetallic strip in the thermostat is the sensing element that reacts to changes of temperature. Its reading is compared to a preset temperature reading of the dial. When a deviation is indicated, the thermostat sends a signal to the servomotor (the starting switch of the furnace). This turns the furnace on until the signal from the thermostat signifies that the correction has been made and the temperature restored to preset value. The switch then turns off the furnace. This system carries out the same functions as the more complicated systems in the automatic factory.

It should be emphasized that computers used for more-complicated closed-loop systems cannot do original thinking. The computer can replace the mental function of an operator only if the process variables can be expressed mathematically and can be predicted and preset into the mechanism. However, if an action occurs upon which the engineers had not counted, the preset information and analyzing process would not be able to cope with this unexpected occurrence.

Thus, when processes are easy to analyze and synthesize in a computer, they are relatively easy to control automatically. When processes are complex and cannot be represented by certain formulae applied to a computing apparatus, the job of automatically controlling them becomes difficult.

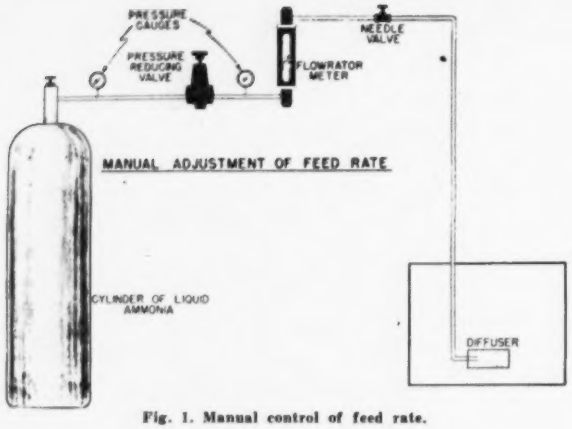


Fig. 1. Manual control of feed rate.

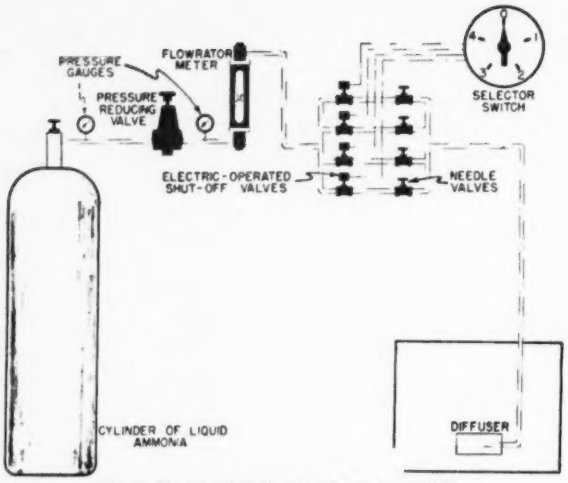


Fig. 2. Step control by use of valve manifold.

AMMONIA FEED CONTROL

METERING and controlling ammonia gas and aqua ammonia can be considered to be one of the easier tasks for instrumentation. Although copper and brass are unsatisfactory in ammonia service, we can use cast iron, steel, stainless steel, corrosion-resistant metals, and a large variety of plastics.

The principles employed for feeding of ammonia gas are to all practical purposes the same as those utilized for the feeding of an ammonia solution or phosphoric acid.

Fig. 1 shows a simple system. Ammonia gas is withdrawn from the cylinder of liquid ammonia at vapor pressure (114 psig. at 70 degrees F.). The pressure is reduced and controlled by a pressure-reducing valve of the spring-opposed diaphragm type. If the possibility exists that there will be a change of back pressure (which could occur with plugging of diffuser) it may be necessary to include a back-pressure regulator, located between the diffuser and the meter.

The diffuser is simple, but some precautions are necessary. It is desirable to release the gas to the waste in small bubbles to assure rapid absorption. Porous stone (for example Aloxite) has proved to be a suitable diffuser material. It is also important to select the proper point of diffusion.

Ammonia gas is highly absorptive in water. When the gas-feeding system is shut down, there is always a possibility that a vacuum will develop within the system as the gas in the piping becomes absorbed in the waste. The vacuum will cause flooding of the system unless a means is provided to bleed in air; commercial vacuum breakers are available.

Presented at 2nd Annual Conference on Instrumentation in Water, Sewage and Industrial Waste Treatment April 20, 1954, Manhattan College, N. Y.

Step Control

Fig. 2 shows a system with step control for flow rate of ammonia gas. Step control is accomplished by two or more electrically (or pneumatically) operated shut-off valves. The electric-motor (or solenoid) valves are energized by a manual selector switch. With the system shown, flow rate 1, 2, 3, or 4 may be selected. Pressure gages, back-pressure regulator, and vacuum breaker should be considered for the system.

Fig. 3 is another step-control system. Here an air-operated motor valve controlled by a valve positioner receives its signal from the selected pressure regulator. The manual selector switch determines which air pilot valve is open.

The step-control systems in Figs. 2 and 3 can be operated automatically by a timer that replaces the manual selector switch.

Unit Dispenser

Fig. 4 shows a standard ammonia dispenser produced as a unit. The dispenser illustrated is a vacuum-type solution-feed unit. A small flow of water is used to produce the vacuum required for operation, and to carry away the ammonia in solution. The dispenser includes automatic shut-off with loss of vacuum, automatic vacuum control for metering and flow control accuracy, vacuum breaker, and emergency vent system.

Ratio Control

Fig. 5 is an instrumentation system for maintaining a manually set ratio of ammonia gas to waste flow. The waste flow is the primary or uncontrolled flow. A meter with transmitter (Parshall flume or Weir) measures the waste flow; a signal converter changes the signal to the required type of signal for the ratio controller.

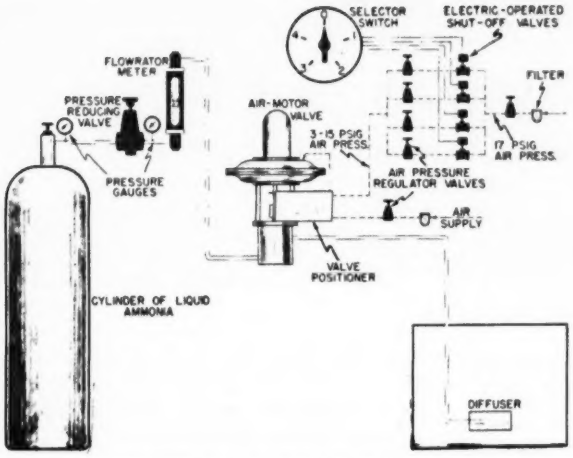


Fig. 3. Step control with valve manifold and air-motor diaphragm valve.

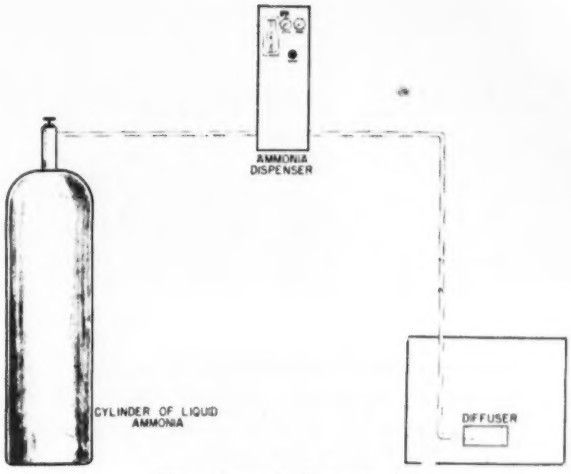


Fig. 4. Ammonia dispenser unit.

by JACK B. BURKE
Fischer & Porter Co.

Nutrient feed systems add ammonia gas to industrial waste and sewage systems. This article traces the development of such feed systems from manual control to automatic BOD control.

The ratio controller receives a second signal from the ammonia-flow transmitter, and delivers the control signal to the air-motor diaphragm valve in the ammonia line.

Automatic BOD Control

Fig. 6 shows the ultimate in complete instrumentation. There is a definite relationship between oxygen and ammonia requirements for nutrient feed control. In the instrumentation system, the key sensing device is the dissolved-oxygen cell. The dissolved-oxygen cell will change air and ammonia gas rates that result from changes in POD (biological oxygen demand) loading, which cannot be detected by the flow-measuring instrument.

We must have a cascaded ratio-control system because three flows are involved: waste, air, and ammonia. The task is to add ammonia at a proper rate (to reduce the BOD regardless of changes in waste requirements) through an intermediate step—the addition of air to maintain dissolved oxygen at a predetermined level. With the system shown, a change in dissolved-oxygen level automatically changes the ratio of air flow to waste flow. A change in air flow will cause a change in ammonia flow because ammonia flow and air flow are at a set ratio. The second ratio controller is responsible for maintaining the proper ratio of ammonia to air. Referring again to the ratio control of air to waste, the dissolved oxygen cell, through an amplifier and air transmitter, pressure loads a bellows at the ratio controller. The bellows operates the ratio selector.

At this time, the writer does not know of a commercial dissolved-oxygen cell that is available for the system described. Laboratory-type cells are available, but a rugged industial-type unit is needed. Realizing it is possible that a dissolved-oxygen cell may already be available, but unknown to the writer, it should be understood that the preceding statement relating to status of equipment on the market is not intended to ignore any manufacturer of such equipment.

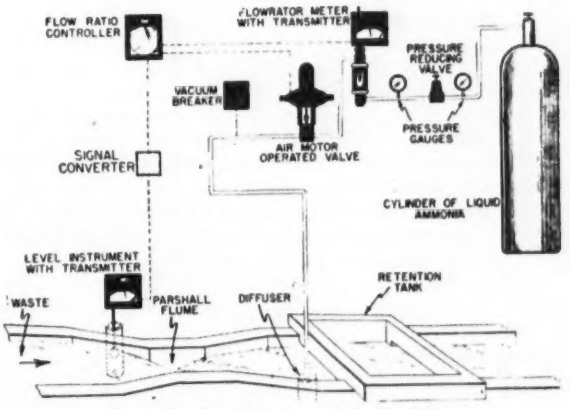


Fig. 5. Proportioning ammonia to flow rate.

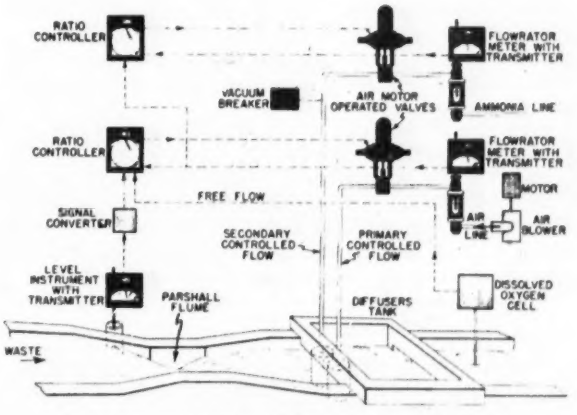


Fig. 6. Automatic BOD (biological oxygen demand) control.

Solving process-control problems by

ANALOG COMPUTER

Process-control problems are susceptible to rapid analysis by use of the analog computer. New and exciting fields of operation await Instrument Departments that apply the new techniques clearly outlined in this article.

by
R. J. MEDKEFF and H. MATTHEWS
Askania Regulator Co.

MODERN plant specifications are becoming increasingly stringent in their demands on the control of process variables. Most plants are in transition through semi-automatic to fully automatic control.

The plant and its controls can no longer be treated separately, but must be considered as one dynamic system. In the design of such systems the engineer often finds himself working in areas where he has no backlog of experience to aid him. If he attempts to use the concepts of modern control theory he finds that the problems are too complex or that portions of the system cannot be sufficiently defined for "by-hand" calculations. The fast-time analog computer has been found by many to be an invaluable aid in the study of such systems, and it is rapidly taking its place as a standard tool.

This article shows the control engineer some of the analog-computer techniques currently in use, how they would be useful aids in the solution of his problems, that they are practical and easily understood, and that they are priced within range of the small office.

Definitions

Mathematical Analogs

Most analog computers in use today are of this type. These machines solve differential equations directly and are at times called electronic differential analyzers. The computer is composed of units which perform mathematical operations such as integration, summation, multiplication by a constant, differentiation (with restrictions), multiplication of two variables, lagged integration and differentiation, and many others which are combinations of the basic operations.

Each unit is composed of a high-gain d-c. amplifier and a particular feedback network which causes the amplifier to perform the desired mathematical operation on the voltage applied. All variables are voltages which are scaled in amplitude, and the independent variable is time. Fig. 1 shows a simple mechanical system, its equations, and the solution as set up by a mathematical analog computer.

Direct Electrical Analogs

Two systems can be said to be analogous if corresponding variables of one behave in the same fashion as those of the other. Inductor-capacitor-resistor circuits can be connected together to form analogs of mass-spring-dashpot systems. Corresponding variables are force—volts; velocity—current; displacement—charge; time—k times time (k is an arbitrary constant). Electrical analogs can thus be built up for any system, provided parameters can be lumped and measured. Fig. 2 shows a direct electrical analog of the system in Fig. 1.

Abstract Analogs

The two methods described presuppose that the system to be studied can be defined, its equations written, and all parameters measured. This is usually true for electrical systems, mechanical systems, aerodynamic and hydrodynamic bodies—but is rarely true for most processes.

A mathematical theorem states that for linear systems, if the response of the measured variable to a step-function change of the controlled variable is known, the response of the measured variable to any change of the controlled variable may be determined. In short, the response to a step function completely defines the relation between measured variable and controlled variable. A corollary of this is that if two systems exhibit the same step-function response, the systems are analogous.

Abstract analogs are then "black boxes," which can be adjusted so that their step response can be made the same as that of the plant or process to be simulated. The

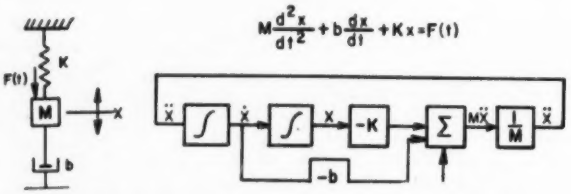


Fig. 1. Mechanical systems, equation, and mathematical analog.

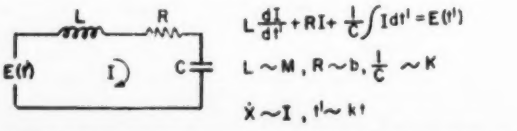


Fig. 2. Electrical analog (direct analog) of mechanical system of Fig. 1, and equation of electric circuit.

Presented at Symposium on Industrial Applications of Automatic Computing Equipment, Midwest Research Institute, 1953.

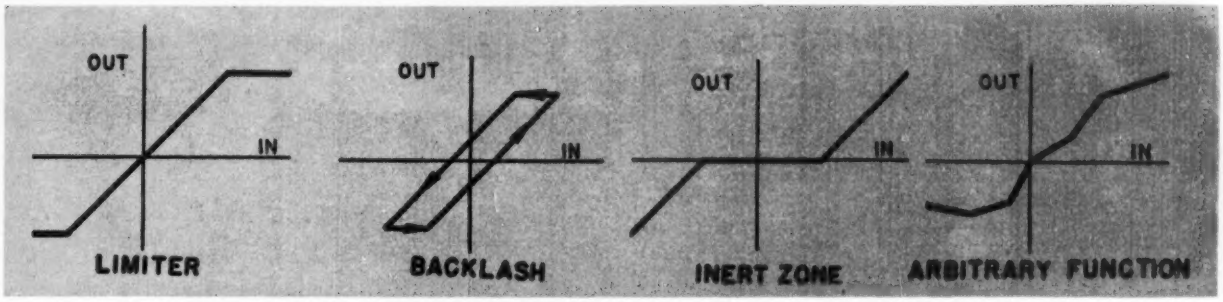


Fig. 3. Typical useful nonlinear functions.

usual procedure is to deal with small step changes so that system linearity may be assumed.

Abstract Analogs of Nonlinear Responses

All analog computers have available devices which simulate nonlinear functions such as dead zone, limits, hysteresis, backlash, and purely arbitrary functions. These are usually diode devices and simulate the desired functions by a series of straight lines. Fig. 3 shows some of the common functions. References cover this subject well.

Time Transformation

Many processes have a normal period which may run into hours. If the analog were to have the same time relationship, many of the advantages of analog study would be lost. Furthermore the requirements of the components regarding size, quality, and cost become prohibitive.

It is convenient to change the time scale so that the process period will be of the order of fractions of seconds to seconds. All of the variables behave as before with relation to each other, but have their time relationship changed by an arbitrary factor. Usually the size of analog components available will dictate a certain range of frequencies over which the analog will function. The time scale factor is chosen to relate the process to this range.

Further advantage may be gained if the frequencies are such that oscilloscopes can be used instead of more expensive recorders.

Procedures

To make the time transformation, choose the arbitrary factor (T) equal to t'/t, where t' is process seconds on analog, and t is real time in seconds.

From which: $Tt = t'$

$$dt = dt'/T$$

If this substitution is made in the equation of Fig. 2:

$$TL'dI/dt' + R'I + (1/TC')\int Idt' = E(t')$$

Analog parameters are chosen so that $TL' = L$; $R' = R$; $TC' = C$.

Note that parameter changes are only made whenever a time integration or differentiation is involved, otherwise no change is necessary.

The same discussion applies to mathematical analogs. Wherever dt appears, substitute dt'/T, and change the value of the time constant accordingly.

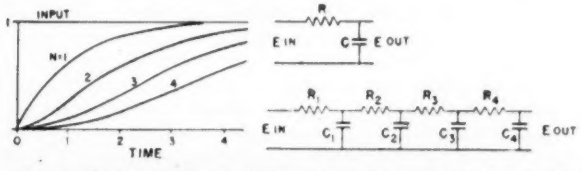


Fig. 4. Electric analog of single- and multiple-capacity plants, and response to step change in input.

Process-control Studies

Most analog-computer installations are combinations of the various types (mathematical, direct, and abstract). Each type works best for specific operations. Process studies make extensive use of abstract analogs.

It will usually be necessary to vary the time base of the problem since the process time may vary from a fraction of a second to several hours.

Process Lags

Many processes have step-function responses similar to those of Fig. 4. These will be recognized as the responses to single, double, triple, and quadruple capacity plants as discussed by Oldenbourg and Sartorius. Fig. 4 also shows resistor-capacitor networks which simulate these responses.

Such networks can, by direct analogy, simulate the flow of heat through different media. Several computers developed along this principle are capable of studying three-dimensional heat-flow problems.

Process Delays

Processes exhibit a certain amount of dead time, or transportation lag (Fig. 5). The delay may be combined with any of the typical responses of plants without delay. The abstract analog in this case might be considered as an extension of the Zeigler-Nichols approach which has been found to be useful by the control engineer.

A method of simulating delay is to use an electrical delay line, made up of a cascade of inductor-capacitor sections. This can be followed by networks and mathematical operations to obtain the desired response. One of the problems with this method is that of obtaining sufficient delay. Commercial lines are of the order of microseconds, whereas even with fast-time-base computers milliseconds are needed. This means that the time scale will have to be chosen so that the actual delay on the real plant will be normalized to milliseconds on the analog.

The response of a cascade of resistor-capacitor lags approaches a delay as the number of lags is increased (Fig. 4). One group reports the use of 80 such lags, with considerable success.

The most common form of delay associated with process systems is that caused by long pneumatic lines which are used for signal purposes. Such lines should be analogous to electrical delay lines, and such lines certainly could be made to simulate a particular pneumatic line

Fig. 5. Plant response with delay.

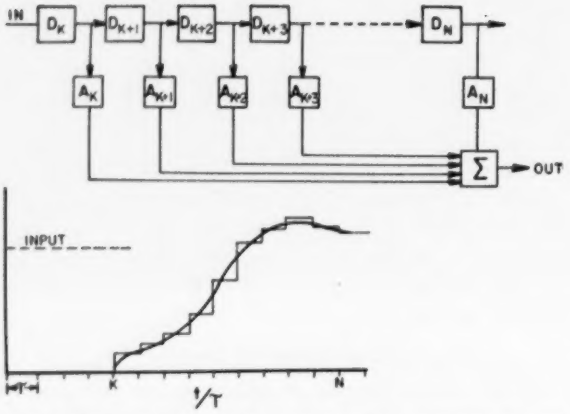


Fig. 6. Universal-analog technique for obtaining an arbitrary response.

closely. However, no sure way has been presented to predict the behavior of a line just from its dimensions.

One paper shows that three cascaded lags can simulate lines and gives experimentally determined time-constants for several sizes of tubing.* One difficulty in this problem is the separation of the line and its terminating impedance. The lines always work into bellows or other pressure-sensitive devices, and no attempt at a match ever seems to be made. The only certain method is to measure experimentally the response of the line and its load and then simulate this on the computer. The subject of pneumatic lines presents many challenging problems, much interesting work could be done with analog computers.

Universal Process Analog

An elegant approach to the problem is a universal analog based on the superposition (Duhamel's integral) principle. This machine is capable of simulating delays combined with a completely arbitrary response, and is versatile in adjustment. Fig. 6 is a block diagram showing the function of this device. The analog is built up around a delay line of forty m-derived sections. The signal may be taken off at each section, multiplied by an arbitrary constant, and all of the components are then summarized. As seen from the diagram, completely arbitrary functions of time and amplitude may be generated. The authors report considerable success with this analog.

Typical Process-Control Problem

Fig. 7 shows the block-diagram solution of a typical process-control problem. The plant is represented by a delay and a lag and simulates a process which was essentially a large tank. The measured variable was gaseous, and it was desired to control the weight flow. The flow sensor was found to be approximately a single-order lag, T_1. A hydraulic regulator performing the functions of proportional plus reset (integral) was used. Two summarizers, an integrator, a coefficient unit K_1 (calibrated in repeats per minute or inverse time constant), and a single-order lag (inherent in the regulator) simulate the regulator. K_2 sets the over-all loop gain, and the final single-order lag represents a hydraulic servo which operates the control valve.

Fig. 8A shows the response of the system to a small step-function change in upstream pressure or control variable: (1) without control, (2) with proportional con-

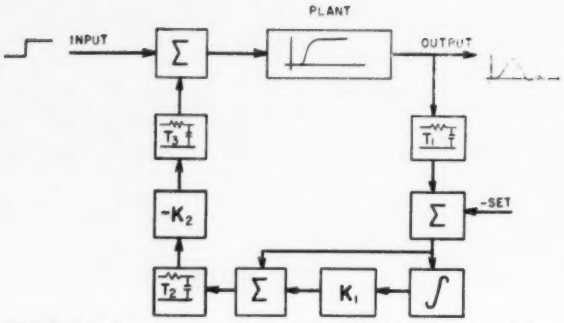


Fig. 7. Typical process-control problem, showing block diagram of simulation technique.

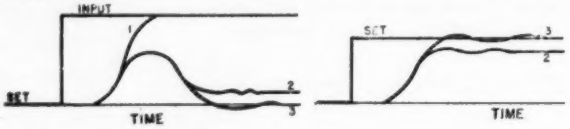


Fig. 8. A (left), response to input step disturbance; B (right), response to step change in set point.

trol only, (3) with proportional plus reset. Fig. 8B shows the responses for a step change in set point. Time scales were chosen so that the results could be displayed on an oscilloscope, and an ordinary electronic square-wave generator was used for the step functions. The controlled responses shown were the optimum. The parameters K_1 and K_2 were determined in a few seconds once the problem was set up. Results: The computer quickly answers the following questions:

1. Will the proposed control system actually regulate the plant?
2. What are the control parameters giving optimum control?
3. What is optimum control?
4. What are the limits of parameters and time constants giving a stable system?
5. Are parameters critical, stability-wise?
6. If dead zone and/or backlash units (Fig. 3) are introduced at appropriate places in the circuit, how precise must components be?

Hydraulic circuits may be more realistically constructed to include flow limits to determine the maximum capacity required of the pumps.

Conclusion

Another useful function, unique with the fast-time analog computer, is the training of plant operating and maintenance personnel. It is difficult to explain to plant personnel the meaning of and reasons for the various control functions. With the computer the operator can be shown what should be expected of his plant, and he can see graphically on the oscilloscope the effects each control parameter has on the various process variables. The computer has been used extensively at Askania for this purpose.

The fast-time computer can also be an invaluable aid in working out starting procedures for complicated systems.

The methods and equipment discussed in this paper are indicative of what is being done in the study of process-control problems. Useful installations costing as little as $5000 are available. One manufacturer sells basic computer components at prices from about fifty to a thousand dollars. With these one can construct general-purpose or special-purpose machines, and the facility can grow as the need arises. No engineering organization is too small to be able to afford such equipment.

* Bradner, Mead, "Pneumatic Transmission," *Instruments*, Volume 22, No. 7, July, 1949.

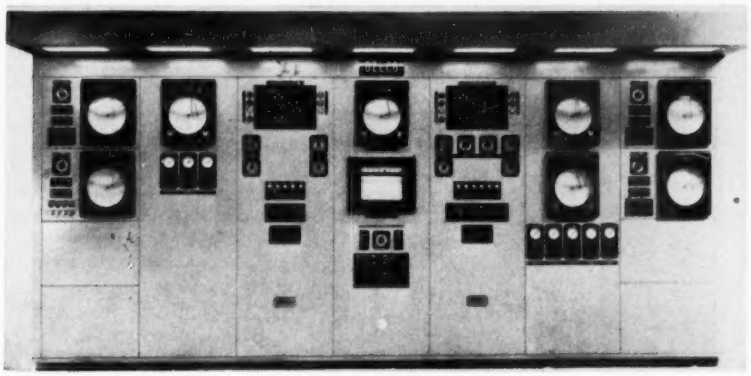


Fig. 1. Central control panel.

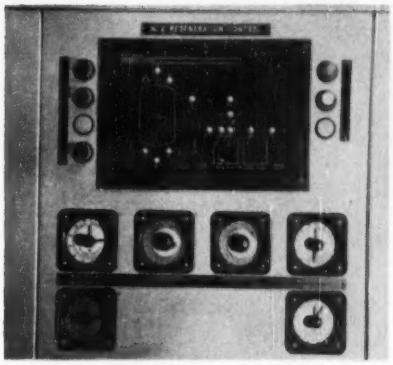


Fig. 2. Closeup of valve diagram for H₂Z unit, showing monitoring lights.

An automatic split-stream system for

BOILER-WATER MAKEUP

Automatic water-treatment facilities are an important part of modern steam-electric generating stations. The modern Hellgate Station of Consolidated Edison Company uses the split-stream system for boiler-water makeup. The design factors and the instrumentation for automatic flow control, alkalinity control, automatic regeneration, and pH are described.

by E. E. PROESCH* and B. UNGERLEIDER**

CONSOLIDATED EDISON COMPANY supplies the Metropolitan New York Area with low-cost electricity because of the efficiency of its steam-electric generating stations. The Bronx Hellgate Station is the second largest generating station in the Consolidated Edison system. Its steam boilers can evaporate more than 7-million pounds of water hourly. The makeup water used in this vapor cycle is furnished by New York City from its Croton supply. This water, the resulting steam, and the return condensate must be free of impurities.

Two batteries of boilers operating at different pressures deliver steam to the turbo-generator units. The low-pressure battery, operating at 275 psig., can evaporate 5-million pounds of water per hour. The remaining boilers operate at 900 psig., and can deliver 2-million pounds per hour. Except for approximately 180,000 lbs. per hour of process steam, the entire output of the station is consumed by the turbo generators.

Design Factors

Makeup water of the proper purity is provided by the Belco automatic split-stream system. This water is added at the condensers supplying the low-pressure boilers. An external-type water-treating plant was justified for the operating conditions. The final decision as to what type of external treatment was made after a careful analysis of current treatment methods. The selected feed-water-treating quipment must (1) deliver water of satisfactory quality to prevent scale formation, corrosion, embrittlement, and carry-over, (2) justify the initial cost, (3) perform dependably, (4) operate economically, (5) assure minimum attendance and maintenance, and (6) provide flexibility of control to meet changing conditions.

Split-stream System

A split-stream system splits the incoming makeup water into two streams, one passing through a battery of sodium units and the other through a battery of hydrogen units (Fig. 3). Both units contain a high-capacity styrene-base resin. The sodium units are regenerated with sodium chloride, and the hydrogen units are regenerated with sulfuric acid. The exchangeable ion in the zeolite is sodium in the sodium units and hydrogen in the hydrogen units. When the makeup water containing calcium, magnesium, and sodium salts is passed through these units their corresponding sodium salts (from the sodium units) or mineral acids (from the hydrogen units) are formed. Calcium and magnesium are removed, providing water of zero hardness. Also in the hydrogen units the carbonates and bicarbonates are converted to carbonic acid, which breaks down to CO_2 and water. The treated water from the sodium and hydrogen units are then blended to provide the desired alkalinity. This equipment is followed by a forced-draft degasifier in which water cascades over a series of trays while air is blown countercurrent to it. This removes practically all CO_2 from the water, and reduces total solids. Before entering the condensers a small amount of sodium hydroxide is fed to maintain proper pH.

*Belco Industrial Instrument Division, Paterson, N. J.
**Fischer & Porter Co., Hatboro, Pa.

Presented at 2nd Annual Conference on Instrumentation in Water, Sewage and Industrial Waste Treatment, April 20, 1954, Manhattan College, N. Y.

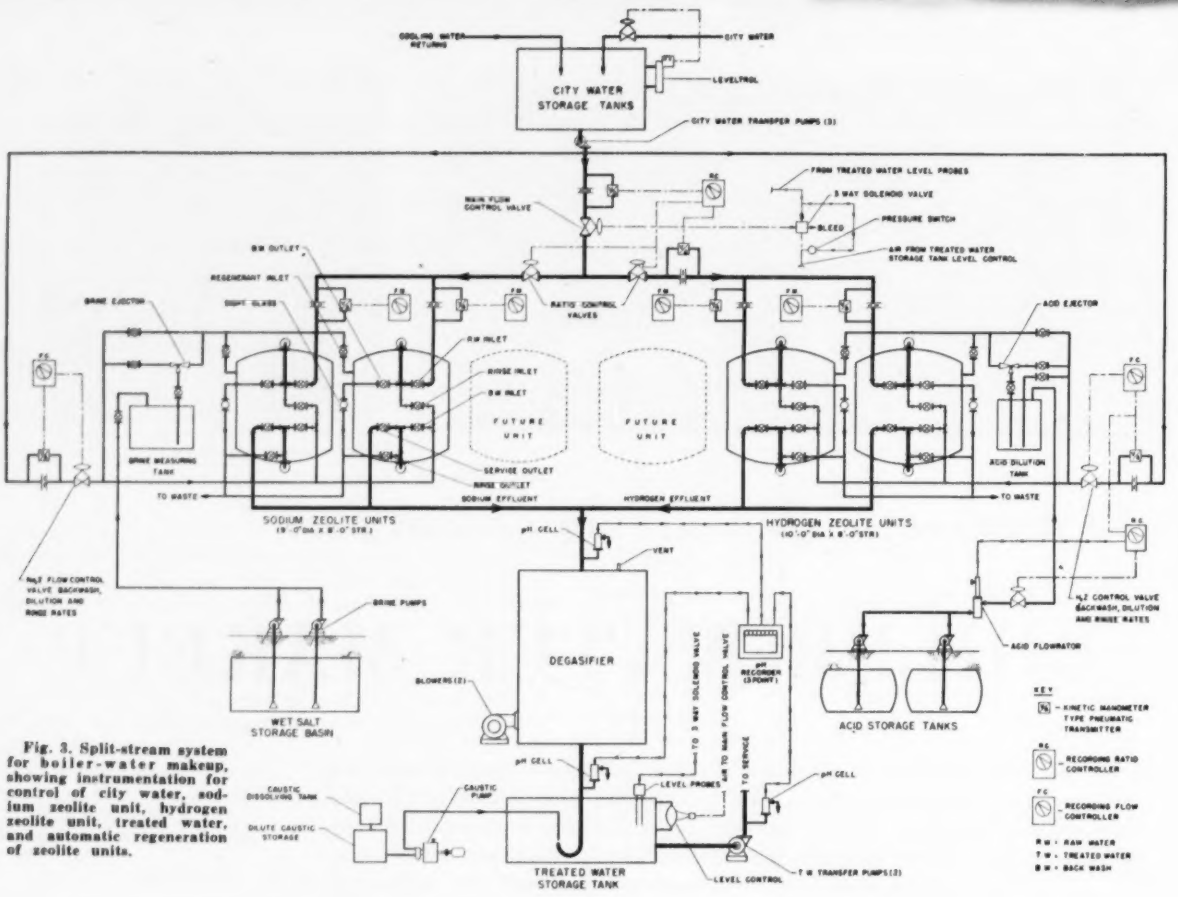


Fig. 3. Split-stream system for boiler-water makeup, showing instrumentation for control of city water, sodium zeolite unit, hydrogen zeolite unit, treated water, and automatic regeneration of zeolite units.

Instrumentation

Since this is a completely automatic installation, all valves directing the flow of water are diaphragm-operated; solenoid valves automatically operate the proper diaphragm valve. Upon failure of the electrical or air system all diaphragm valves will close. With the exception of the solenoid valves all electrical controls and recording instruments are mounted on the central control panel. Located on this panel are two valve diagrams—one for the hydrogen units (Fig. 1) and one for the sodium units. These diagrams show all the on-off diaphragm-operated valves. Each diaphragm valve has an indicating light located in its proper place on the flow diagram.

Flow Control

Makeup water for the system is provided by city water storage tanks. Cooling water returns from bearings, etc., enter this tank uncontrolled. City water is introduced into the tank to maintain a minimum level and is controlled by level-control equipment. Three city water transfer pumps, each capable of delivering 500,000 pounds per hour at 70 psig., supply water to the zeolite treatment system.

The total flow through the zeolite system is controlled from the level in the treated-water storage tank (top of Fig. 3). A level control located on this storage tank throttles the main flow-control valve located on the inlet to the zeolite units. A pressure switch is provided in the air line to the control valve. When the flow of water drops to between 10 and 25 percent of maximum, this pressure switch stops the city water transfer pumps. As the elevation of the degasifier is higher than the zeolite units, this stops all water flow through the system. A level probe starts the system back in operation after a 3-ft. drop in level.

Alkalinity

In order to provide water of the desired alkalinity, the sodium and hydrogen effluents must be blended properly.

As all flow measurements are recorded on the central control panel, it is necessary to transmit the flow rates from the orifices to recording instruments located on the panel. A Fischer & Porter V/A kinetic manometer with pneumatic transmitter was installed in the total water flow line and another V/A cell in the hydrogen water line. The installation (Fig. 4) consists of an orifice plate between two orifice flange unions and a V/A cell located adjacent to it. The V/A cell meters a small bypass flow created by the orifice differential; this flow is proportional to the main line flow. The V/A cell converts this flow rate into an air-pressure signal which is transmitted to the recording instrument on the control panel.

Pneumatically-operated control valves are installed in both the sodium and hydrogen water lines, one valve is air-to-open and the other valve is air-to-close. The pneumatic flow-rate signals from the V/A cells are transmitted to the panel-mounted recording ratio controller. This ratio controller serves as a total-flow meter, and also maintains the desired blend of sodium-hydrogen water by controlling both valves. The valves are designed carefully to keep the control system stable. Included in the ratio-control instrument is a totalizer which provides an electrical contact that operates a timer, which in turn operates a caustic pump. This caustic pump maintains the proper-pH water in the treated-water storage tank.

Automatic Regeneration

The sodium units treat 10-million lbs. and the hydrogen units 9-million pounds of Croton water before requiring

regeneration. In order to initiate automatic regeneration of these units, the electrical control system must be notified when the desired number of pounds have been treated. To accomplish this, recording totalizing flowmeters are provided on the inlet of each ion-exchange unit. V/A cells are installed on the inlet line to each unit. Each of the signals from the V/A cells is received by a pneumatic flow recorder with a 24-hour chart. In addition, a totalizer is installed in each recorder case, integrating the flow and providing a contact every 40,000 lbs. to an electrical counter. After the required number of contacts is received from the totalizer, the counter trips a relay which initiates the regeneration cycle.

For proper automatic regeneration, all flow rates required to backwash, inject chemicals, and rinse the units must be controlled carefully. It is necessary to automatically dilute concentrated sulphuric acid to different specified concentrations for regenerating the hydrogen units. A V/A cell with orifice plate is installed in the water line (shown at right in Fig. 3); its output signal is fed to (1) a flow recorder-controller with pneumatic set-point adjustment, and (2) a ratio controller. The flow controller controls the backwash, acid-dilution, and rinse water at required flow rates as determined by three air-loading stations. These air-loading stations set the control point on the flow controller which is a "Type P Pneumatrol" with wide proportional band and automatic reset.

The ratio controller automatically proportions the flow of concentrated acid to the controlled water flow. A Fischer & Porter "Fig. 735-OL" electrical transmitting "Flowrator" meter with "Hastelloy C" metering float is installed in the concentrated-acid line. The position of the metering float varies the inductance in a transmitting coil, which positions a matching coil in the ratio controller. The signals (one from the controlled water line and one from the acid line) are fed into the ratio-control mechanism, whose output positions a "Type P Pneumatrol" (with wide proportional band and automatic reset) to control the valve in the concentrated-acid line. The ratio of acid to water is set pneumatically from two air-loading stations, one providing 2-percent acid and the other providing 6-percent acid. This ratio controller is also equipped with a totalizer, which provides contacts to electrical counters. These counters control the operation of the acid pumps.

The regeneration of sodium units is accomplished with brine. No automatic ratio system is necessary and the only instrumentation involved is a flow controller on the sodium water line, with adjustable pneumatic set. The control system consists of the V/A-cell indicating pneumatic transmitter with orifice plate, the panel-mounted flow controller with the pneumatic set, and a pneumatically-operated control valve in the water line.

pH

In order to raise the pH of the treated water, caustic soda is fed into the storage tank by a positive-displacement pump. This feed is proportioned to the inlet water flow. The feed is intermittent and the frequency of feed depends on the total flow through the system. A 3-point pH indicating-recorder provides continuous pH readings before and after the degasifier and after caustic feed. The pH of the water entering the degasifier implies whether the proper blend is being used. The difference in pH across the degasifier signifies the amount of CO_2 removed. The final pH point indicates the efficiency of the caustic feed.

These instruments provide a positive means of controlling and monitoring the entire system. With a minimum of effort and maintenance a relatively inexperienced operator can control the operation of the equipment from the central control panel. Numerous additional alarms and

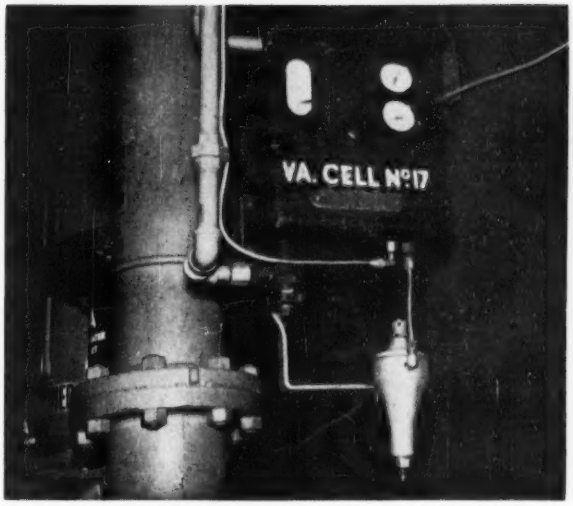


Fig. 4. V/A bypass-flow-type flowmeter installation with local indication and pneumatic transmitter.

controls are incorporated in the design. The expense of the automatic controls and instruments will be more than offset by decreased labor costs.

Modern steam-electric generating stations are becoming more automatic. To keep up with the industry, water-treatment facilities must follow suit.

Acknowledgement

The authors would like to thank Mr. T. Schenck of the Consolidated Edison Company for his cooperation in the preparation of this article.

Discussion From the Operator's Viewpoint

by W. J. NOON, Consolidated Edison Company

The savings in production costs can be appreciated by considering a few basic economic factors. The current cost in this area to provide an operator for three shifts, 365 days a year, is about $25,000. Now, in the construction of a new plant, if the cost of instrumenting a process to provide automatic operation is amortized over a six-year period, $150,000 can be spent to install the instruments. From this must be deducted the cost maintenance. Newton and Aries give a figure for maintenance of 2 to 10 percent of plant cost. Taking the conservative figure, this would leave $90,000 available for instrument installation, before taxes.

Uniform flow and uniform control of process variables will result in decreased costs. Elimination of surges enables equipment to be operated nearer to its ultimate capacity, or, to look at it another way, smaller equipment can be used to produce a given throughput.

The advantages of a permanent and continuing record of operations can be appreciated by anyone who has had the job of reconstructing events which have led to trouble or operational error.

Alarms and automatic tripouts eliminate costly damage to equipment, and provide an extra safety factor for the operator. As processes become more complex, it becomes difficult and unfair to hold the operator responsible for shut-down when necessary for the safety of equipment or personnel. Alarms which require corrective action to be taken before the alarm indication can be removed should be used. A simple on-off switch should never be used. I have seen operating boards with half the alarms switched off and troubles ignored. Don't provide an "easy out" for the operator, but insure corrective action being taken.

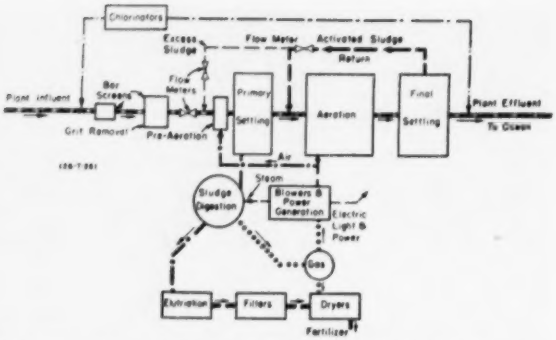


Fig. 1. Flow diagram of the Hyperion Sludge Plant, City of Los Angeles.

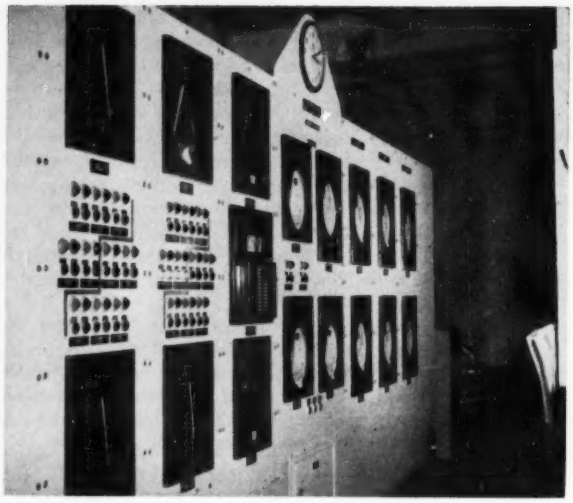


Fig. 2. Control panel for Battery A.

Instrumentation experience at an

The Los Angeles Hyperion activated-sludge plant is a fully-instrumented modern sewage plant. This survey of the plant and its instrumentation reveals unique methods and alternate arrangements for maximum efficiency and recovery of materials.

by JOHN W. O'HARA
Minneapolis-Honeywell Regulator Co., Brown Instruments Div.

MERITS of instrumentation as applied to waste-disposal facilities, and the economics of sludge-digester instrumentation have been explored at considerable length. One of the finest examples of a fully-instrumented, modern sewage plant is the Hyperion Plant of the City of Los Angeles. This plant produces a final clear effluent of 245 mgd. The sludge-digestion system consists of 18 2,500,000-gallon tanks, in three batteries of six tanks each. Thus the total digester capacity is 45,000,000 gallons.

Fig. 1 shows the process layout. Fig. 2 shows a battery control panel. This plant was designed by Lloyd Aldrich, Los Angeles City engineer, in cooperation with Metcalf & Eddy, Consulting Sanitary Engineers. The plant, which cost approximately $42 million, began operation in May, 1950.

The basic instrumentation applied to these digesters is illustrated in Fig. 3, which shows the instruments required for flow and level measurement.

Presented at 2nd Annual Conference on Instrumentation in Water, Sewage and Industrial Waste Treatment, April 20, 1954, Manhattan College, N. Y.

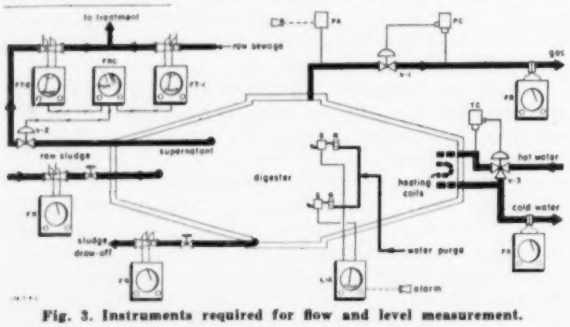


Fig. 3. Instruments required for flow and level measurement.

Temperature

Digester temperatures are checked by a single thermocouple in each tank, which is mounted in a protecting tube 42 inches long. As each tank is equipped with a mixer which keeps the sludge in constant motion, the single thermocouple is satisfactory. Stainless-steel protecting tubes now have replaced the original wrought-iron tubes, which eroded through in approximately two years. These protecting-tube failures signalled their presence by allowing gas to escape. If original wiring had been in explosion-proof conduit, this unpleasant and potentially explosive mixture might have been prevented.

Temperatures in the digesters are maintained by a conventional coil system (Fig. 4). Note that both the inlet and outlet water should be monitored for temperature. A marked decrease in the differential across these coils is usually indicative of caking on the outside of the coils. This, of course, cuts down the heat transfer from coils to

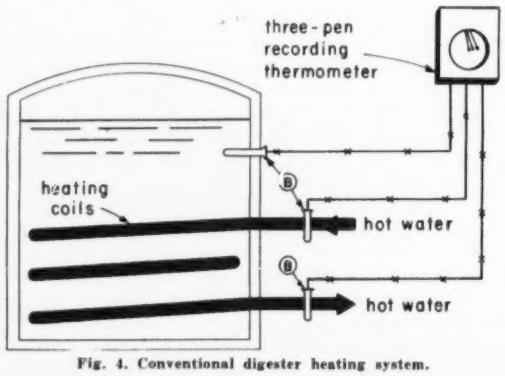


Fig. 4. Conventional digester heating system.

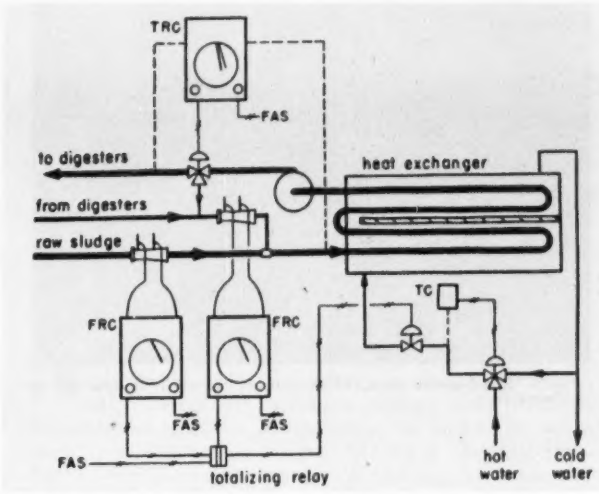


Fig. 5. Alternate type of sludge-heater system.

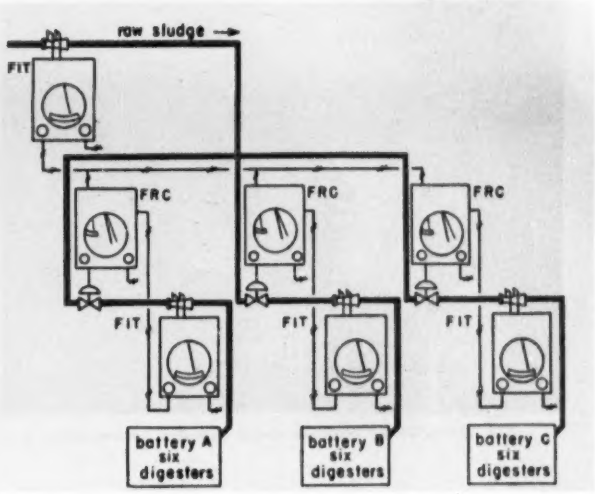


Fig. 6. Raw-sludge distribution system.

Activated-sludge Plant

sludge, and requires more heating water per unit of heat transferred. A high-temperature alarm is desirable on the inlet side of the coils because inlet water temperatures in excess of 130 deg. F. accelerate the caking process.

An alternate type of sludge-heater system is shown in Fig. 5. Here the sludge is pumped out of the digester and passed through a heat exchanger. A temperature control, operating in the return line from the heat exchanger, maintains proper sludge-heating conditions by throttling input steam or heater fuel. This system might remove the need for mixing equipment.

Flow Ratio

One of the most unique installations at this plant is the ratio control of raw sludge to the three batteries of digesters. The raw-sludge distribution system is shown in Fig. 6. Raw sludge is metered through a 16-inch Venturi, and then is divided through three 12-inch Venturis to the digester batteries. Flow ratio controllers allow each battery to receive from 8 to 57 percent of the influent. In operation, two batteries receive controlled proportions, and the third receives the balance. It is apparent that this system offers considerable flexibility—a partially disabled battery can be left on the line but can be fed only a small portion of the flow. Fig. 7 shows one of the ratio installations.

Steam flow to the digester heating coils is ratioed in an identical manner, using orifice plates rather than Venturis. Sludge temperatures are maintained between 90 and 95 deg. F. The low-pressure steam used is provided by waste-heat recovery equipment which operates on the exhaust from the Diesel power units installed. Fig. 8 shows these dual-fuel power plants, which operate either on digester gas or purchased fuel.

Liquid Level

The greatest number of similar instruments used in this plant are those used for digester level measurements. Two instruments are used on each tank, making a total of 36 units.

One group of 18 instruments is mounted outdoors, one to a digester, as shown in Fig. 9. These level indicators are of the diaphragm-box, static-pressure type, and measure full digester level, 0 to 30 feet. A second group of 18 instruments, mounted in the control rooms, shows the level in the upper operating portion of the digesters—namely, from 15 to 30 feet. This second group is of the bubbler type. All of these instruments are equipped with high-low level-alarm signal units, which function through an annunciator system to indicate level extremes by means of a coded gong signal.

Operating experience has shown that a number of precautions must be considered, as follows: (1) High-low alarm signalling units, when mounted outdoors, must be constructed so that moisture condensation in the unit can be prevented, particularly where salt air is present. (2) Adequate purge connections must be provided where instrument sensing lines enter digesters (Fig. 10). Ramming operations, during cleanout, would be facilitated if the sensing-element connections and lines are of sufficient size. In addition, hose connections should be provided so that a pressure purge can be used if necessary. Pressure-relief valves are necessary when pressure purging is used to prevent damage to the sensing diaphragms.

The digesters are operated under a gas pressure of from 5 to 7 inches of water; therefore, a 6-inch zero offset was made in the level indicators to correct the level readings.

Flow

Large amounts of grease collect in the various lines; particularly in the downstream cones of the raw-sludge Venturis. (A two-inch coating has accumulated in these units over a two-year period.) Many devices are available for cleaning lines of grease, but these devices cannot be passed through Venturis. Frequent Venturi cleaning would be an expensive proposition; therefore, an ingenious scheme has been devised to forestall this. Piping has been modified so that raw sludge may be temporarily by-passed through the digested-sludge Venturi. Thus this Venturi,

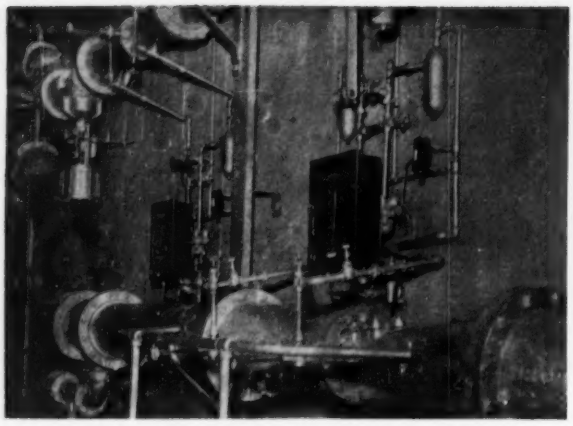


Fig. 7. One of the three raw-sludge ratio-flow control units.

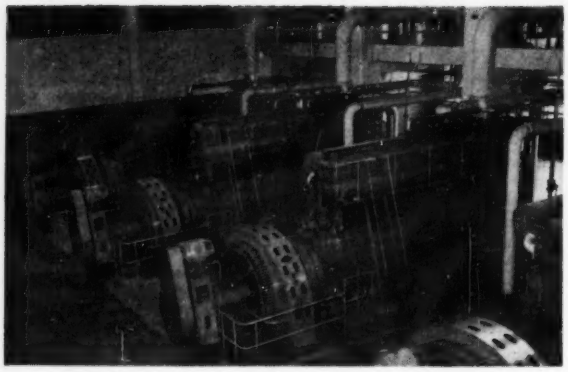


Fig. 8. Diesel power plant, which operates on either digester gas or purchased fuel.

which remains clean since the grease is digested, may be used to calibrate the raw-sludge Venturi. Compensation then can be made for calibration shifts due to effective Venturi throat-diameter reduction. Intervals between cleaning may be lengthened, commensurate with the amount of calibration adjustment which is built into the instruments. Longer calibration adjustments might increase the cleaning interval, provided Venturi capacity did not limit its used because of restricted flow maximums.

Water purge lines should be of sufficient size so that velocity effects set up by changes in purge flows do not materially affect flowmeter-reading stability.

This plant is equipped with piston-powered grease ejectors which periodically pump grease from the skimmers into the digesters. Flow pulsations induced by ejector action force sludge back into the meter bodies. The frequent cleanout required would be made less difficult by provision of adequate cleanout facilities, plus the use of larger sediment traps. The best solution to this condition was the installation of check valves. Instrument cycling, induced by these ejector pulsations, frequently was greater than the scale span. In order to prevent this cycling and to produce a satisfactory indication, the dampening adjustments on the meter bodies must be nearly closed.

Digested sludge is pumped to the elutriation system, consisting of two counter-current wash tanks and one concentration tank. Effluent sludge from these tanks is chemically conditioned and filtered on vacuum filters. The filter-produced sludge cake is conveyed to a battery of four dryers, which produce fertilizer of 10 percent or less moisture, or is incinerated to ash. Digester gas may be used for the burners used in this step. Maximum output of fertilizer should be in excess of 200 tons per day. Plant effluent is used for irrigation and the grit is used as fill.

Proper application of instruments has made maximum recovery of useful materials possible. The widespread use of instrumentation in sewage-treatment plants has been accepted reluctantly over a long period of time. In general, full recognition of the economic and operating gains which may be obtained has not been realized. The Hyperion plant installation has proved the value of instrumentation in sewage treatment.

More widespread realization of the benefits which may be derived from automatic control, through proper application of instrumentation, will result in considerable gains to sewage-plant superintendents. Miniaturization of instrumentation and the use of graphic panels offer more attractive possibilities for reducing costs.

Acknowledgement

The author appreciates the assistance of the following people in assembling the material used in the preparation of this paper: Jack M. Betz, Los Angeles City Engineer, and J. W. Segraves and E. S. Ferree of Minneapolis-Honeywell Regulator Co., Brown Instruments Division.

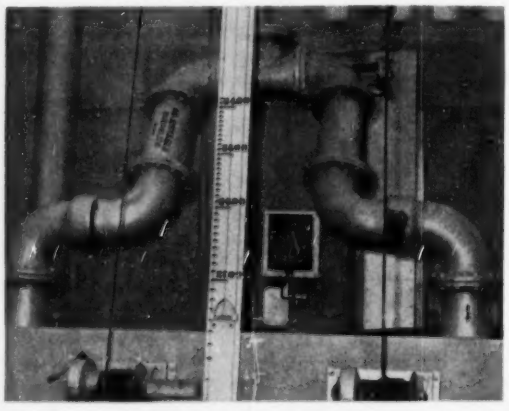


Fig. 9. Level indicator of static-pressure diaphram-box-type on digester tank.

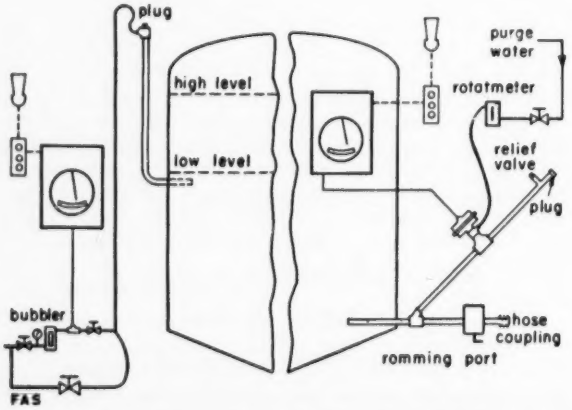


Fig. 10. Level measurement and alarm system for digester.

New technique for control of
ION-EXCHANGER ENDPOINT

by MARTIN E. GILWOOD, The Permutit Company

NO suitable automatic device has been available to indicate the end of the operating run of a hydrogen cation exchanger (hydrogen zeolite) unit. Although thousands of units are in operation, the end of the operating run is determined either (1) by a chemical titration by the plant operator or (2) the run is terminated when a fixed volume of water has passed through the unit. Control by pH has been unsuccessful because changes in pH at the end of the operating runs are small.

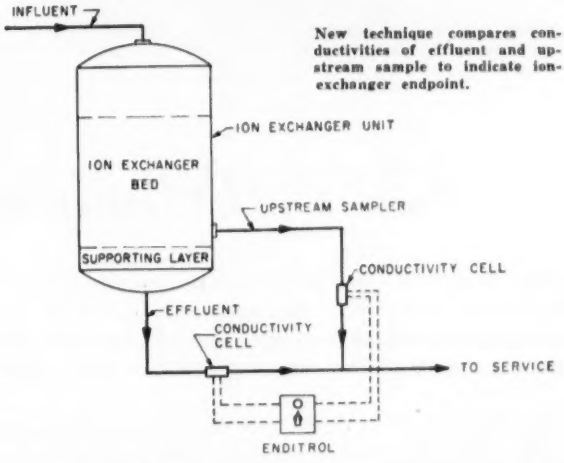
An endpoint indicator would not only indicate the end of the operating run but also automatically initiate operation of automatic regeneration equipment. It also would eliminate the dangers of over-running and the chemical and water wastages caused by under-running.

In developing the "Enditrol" advantage was taken of the fact that a columnar bed of ion exchanger, when operated downflow, has its useful exchange capacity exhausted first at the top; this exhaustion then proceeds slowly downward during the operating run, the bottom of the bed being the last portion to become exhausted. In the case of a hydrogen cation exchanger, the calcium, magnesium, and sodium cations are taken up from the water passing through the bed, and hydrogen ions are given in exchange for them. Therefore, the effluent contains amounts of carbon dioxide, hydrochloric acid, and sulfuric acid equivalent to the amounts of bicarbonates, chlorides, and sulfates present in the raw water. With the sodium salts in water, the exchange is not quite complete and there is usually a slight slippage of sodium chloride and sulfate through the bed.

As decreases in acidity proceed slowly downward through the bed during the run, it appeared that if samples were drawn off at a level somewhat above the bottom of the bed, the differences in acidity between these samples and the final effluent could be used to indicate the end of the run. The tap may, in practice, be about 4 inches to 8 inches above the bottom of the bed.

As shown above, a small stream of water, drawn from this tap continuously during the operating run, is passed through a conductivity cell and its conductivity is compared in the "Enditrol" with the conductivity of the effluent from the bottom of the exchanger. During the run, the ratio of conductivity equals 1.0. But, as hydrogen ions have an appreciably higher conductivity than the metallic ions (calcium, magnesium and sodium) which they have replaced, the effluent, near the end of the operating run, has a higher conductivity than the upstream sample taken from the tap. Depending on the position of the upstream tap the ratio of the conductivity of the effluent to that of the upstream sample may range from 1.2 to as much as 3.0.

As the "Enditrol" operates not on the conductivity of the effluent but on the ratio of the conductivities of effluent and upstream sample, waters of variable composition



New technique compares conductivities of effluent and upstream sample to indicate ion-exchanger endpoint.

may be handled as accurately as waters of constant composition. The controller may be equipped with relays, alarms, lights, and devices to make the unit automatic.

Anion Exchangers

The "Enditrol" is equally applicable to the operation of anion exchanger units—especially in operation of strongly basic anion exchangers in demineralizing installations where silica removal is of importance.

In a "two-step" demineralizing installation, during the operating run of a strongly basic anion exchanger unit, the anions are taken up in a more or less preferential manner by the anion exchanger bed. The sulfate ion is taken up first, the chloride ion next, then the bicarbonate ion, and finally the silicate (silica) ion. While the stratification is not too sharply marked, silica leaks through the bed before any leakage of the other ions occurs.

As silicic acid is a weak acid, it does not ionize sufficiently to affect either the pH of the effluent or its conductivity. However, as the strongly ionized hydrochloric and sulfuric acids are following the silica, the sampling tap can be placed far enough upstream so that their presence can be detected before silica appears in the effluent; the hydrochloric and sulfuric acids in the upstream tap sample cause the conductivity of the sample to rise rapidly and indicate the end of the operating run. By proper location of the upstream tap sample, this rise in conductivity will occur when the silica just starts to rise in the effluent. For this application it is not absolutely necessary to compare the conductivity of the upstream tap and the effluent; the end of the run can be determined merely by checking the upstream tap for an increase in conductivity.

A similar arrangement can indicate the end of run of a mixed-bed demineralizing unit; the run can be terminated at the first increase in effluent silica and not when the conductivity of the effluent rises.

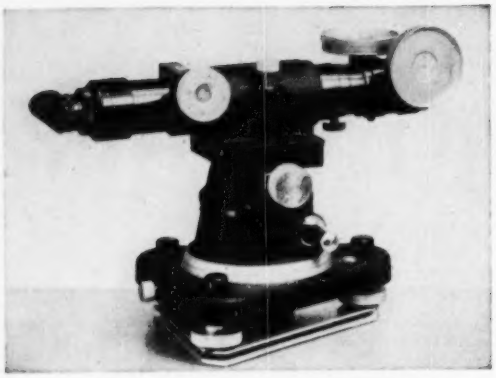


Fig. 1. Typical alignment telescope on stand.

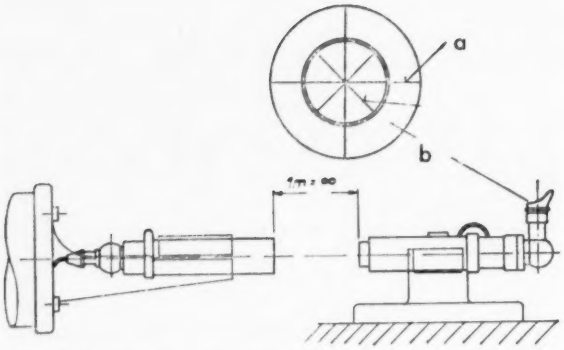


Fig. 2. Alignment test; (a) measuring mark; (b) sight mark of lens of collimator aligned. Measuring mark is mounted on front of collimator at left.

Principles and Applications of

Alignment telescopes are versatile instruments for levelling benches and bedplates, for testing the perpendicularity of machine-tool guides, for aligning bearings in the motor- and textile-building industries, for measurement of large railway constructions, and for other alignment problems.

ALIGNMENT TELESCOPES (Fig. 1) use light rays (instead of rulers or clinometers) as a straight edge and as an absolute perpendicular. Two sights are used —a *measuring mark* and a *sight mark*. The measuring mark is mounted at points on the guideway or lathe bed to be tested; the sight mark, mounted in the telescope, is then aligned with the measuring mark by adjustments on the telescope. The deviation between the marks can be measured to indicate misalignment.

Alignment Test

Testing the guideway of a machine tool (Fig. 2) takes place by sliding the measuring mark along the guideway. The telescope is then adjusted, first at the beginning and then at the end of the guideway distance, and is sharply focused each time. The lens, when sharply focused, moves only perpendicularly. It is also possible to focus sharply several measuring marks which are placed consecutively, as for aligning bearings.

The precision of the measurements depends on the distance. As the graduations of the measuring mark are seen more feebly with increasing distance, the design of the measuring mark has to be chosen so that its width does not influence or impair the measurement.

Deviations from the line of alignment can be evaluated by an adapter fitted to the head of the alignment telescope. This is achieved by two pairs of plane glass discs, one of which can be turned through the horizontal, the other through the vertical axis. Tilting can be read off micrometer drums. As the movement of the light rays through the pairs of discs takes place parallel to the optical axis, the values on the drum are the same for all distances.

Direction Test

If two benches are being rigged consecutively, and if their guideways have to be levelled, a collimator is used (Fig. 3). The collimator scale can be seen through the lens fitted in front of the telescope. If the axis of the collimator is inclined, its scale is seen out of alignment with the telescope. The collimator is shifted parallel to the optical axis of the telescope, but, even taking that into account, no shift in the markings will be observed. The precision of the instrument is independent of distance. This distance test does not involve the auxiliary measuring gear.

In lieu of the collimator a mirror may be fixed so that the image of the sight mark reflects itself in the eye-piece of the telescope. The double distance endows this type of measurement with correspondingly higher precision. It is subject to a lighting system inside the eye-piece.

Deviations of the measuring mark from the optical axis of the alignment telescope can be measured by using a supplementary gear. Vertical and lateral deviations can be read separately off one of the measuring drums for this purpose (up to 0.02 mm. in one model). The measuring range in both directions is ± 2.5 mm. in one type. Independent of the clearance of the measuring mark, the absolute value of the deviation always can be found. The alignment telescope can be supplied with a prismatic prefixture (with which it is possible to make observations at an angle of exactly 90 degrees) in order to align the traverse perpendicularly to the guideway in large machine tools.

The measuring mark is adjusted to suit the purpose in hand. For example, there can be affixed a point, a circle, a dash, or a special reticle (Fig. 4).

The collimator has an incorporated protractor and interchangeable lighting system.

The front of the collimator is equipped with a measuring mark so that it can be used for alignment tests. A clinometer sight fitted to the tube ensures exact alignment.

For levelling the alignment telescope, a solid and omnidirectionally adjustable stand has been provided. It can be levelled by knurled screws and a spirit level.

Precision of Measurement

Precision of measurement depends on the distance. In one model, at a distance of 3000 mm. a deviation of 0.015 mm. can be measured. Repeated measuring can reduce this to 0.005 mm. which, in practice, can be disregarded.

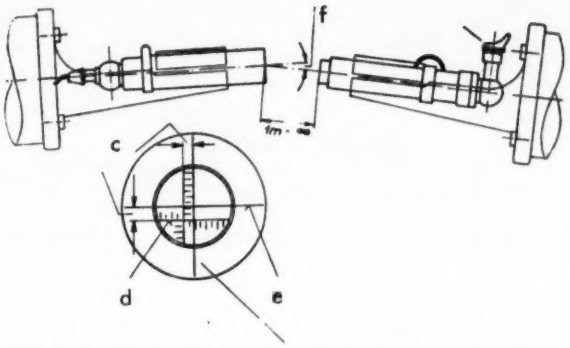


Fig. 3. Direction test; (c) deviation of angle; (d) readings of collimator; (e) sight mark of telescope; (f) deviation error exaggerated.

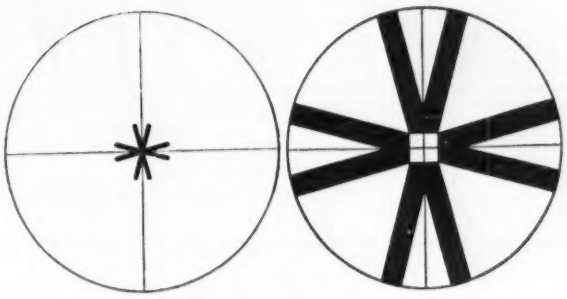


Fig. 4. Types of reticle.

by A. METZ
George Scherr Optical Tools, Inc.

ALIGNMENT TELESCOPES

Applications

When testing the alignment of a lathe bed the first thing to be decided is whether the guideway has to be examined by itself or whether the examination is to be carried out with the support mounted. In the first event, the measurement instrument has to be fitted with a special slide, the lower part of which fits into the guideway. The telescope is erected at one meter, the shortest distance possible. In the second event, with the support mounted, the telescope is best fitted into the boring of the headstock with a clip so that it stands vertically and parallel to the boring machine. The measuring mark is mounted to the support at the correct height. With long machine beds it is possible also to insert the telescope into the guideway, making use of the parallel survey, thus ensuring an immediate and correct direction and making special alignment unnecessary.

In any event, when beginning the examination the measuring mark is shifted up to the limit stop and made to correspond with the sight mark in the ocular. Then the measuring mark is gradually moved towards the telescope and deviations are measured through the attached accessory. Readings of the micrometer drums can be plotted so that it is not absolutely necessary that the optical axis of the telescope, before beginning measurements, corresponds exactly with the alignment of the guideway to be tested.

For aligning several bearings and borings which are consecutive the measuring marks are inserted with different holders which can be easily centered (Fig. 5). Centering is achieved by tilting (turning the measuring mark). When focusing the measuring mark, the quality of the image is not affected by the other marks inserted into the borings; they can remain where they are. The outer one is equipped with the lighting system.

Before sighting the rotation axis of the spindle it is necessary to affix one graduation mark each at the beginning, and one at the end of an existing spindle boring, exactly centered with the axis of rotation. In lieu of the two marks a running holder, running precisely with alignment collimator, is used.

If the benches of large machine frames are to be aligned the telescope can be traversed horizontally with the aid of a stand. One of the plates should then be in the center. It is essential with all measurements to provide a stable mounting for the telescope.

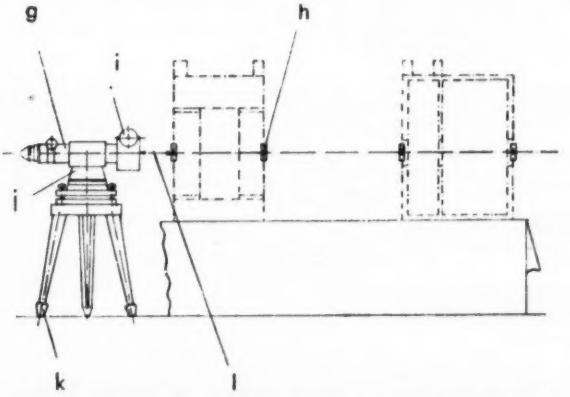


Fig. 5. Alignment of borings; (g) alignment telescope; (h) sight mark; (i) prefixture, with range of measurement of 2.5 mm.; (j) stand; (k) tripod; and (l) minimum distance 1 m.

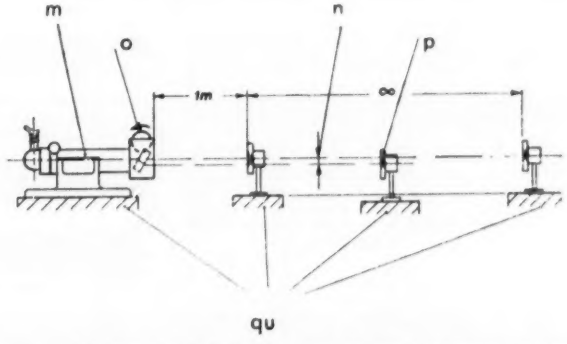


Fig. 6. Direction test of lathe beds; (m) alignment telescope; (n) deviation of height; (o) range of measurement 2.5 mm.; (p) sight mark; (qu) test areas.

Journal of the S C M A . . .

SOUTHERN CALIFORNIA METER ASSOCIATION

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Fundamentals of COMBUSTION CONTROL SYSTEMS

Basic combustion-control systems use on-off, proportional, and reset modes of control. Fuel flow, air flow, and fuel-air ratio (the basic controlled parameters) are controlled by series or parallel arrangements from measurement of steam header pressure, steam flow, and air flow.

by A. WAXMAN
Hagan Corporation

AUTOMATIC COMBUSTION-CONTROL systems for boilers have three basic functions, irrespective of size, operating pressure of boiler, method of firing, or fuels used. The first function is controlling the supply of fuel in accordance with load demand, usually as indicated by variations in steam header pressure. The second function is controlling the flow of combustion air to the fuel-burning equipment, and maintaining a predetermined relation between the quantities of air and fuel supply. The third function is controlling the removal of the products of combustion at the rate required to maintain the furnace pressure or suction.

Automatic control of the supplies of fuel and combustion air to a boiler furnace can be accomplished in different ways. The method selected depends on the initial cost of the control equipment, the available operating manpower, maintenance requirements, over-all efficiency realizable, and safety features. The details of the system are determined by the size of the boiler unit, and the number and character of the fuels to be fired.

On-off Control for Small Units

Small boiler units are generally subject to load demands of an intermittent type, and employ controls which either admit fuel to the boiler at a predetermined rate, or shut off the fuel completely. This is "on-off" control.

If the normal operating pressure, for example, is 100 psig., the controller might be adjusted to supply fuel and air to the furnace in the range between 95 and 105 psig. (Fig. 1), with fuel firing being started at 95 psig. and shut off at 105 psig. Such control is usually of the electric type, sensing steam-header-pressure variations, and actuating the electrical controls of the blower supplying air for combustion. After a predetermined period of purging the furnace to insure against flarebacks, the ignition system is programmed to operate just prior to the opening of the fuel-control valve. Failure of the burner to light within a predetermined time would operate controls to close the fuel-control valve immediately.

As soon as the firing process is started, the discharge pressure of the combustion-air blower is used to operate electrical contacts to keep the fuel valve open. When the steam header pressure reaches the maximum value, both fuel and air are shut off simultaneously.

This type of system often includes equipment for closing the stack damper through electrical interconnections, with the damper being opened just prior to the introduction of fuel and air to the burners.

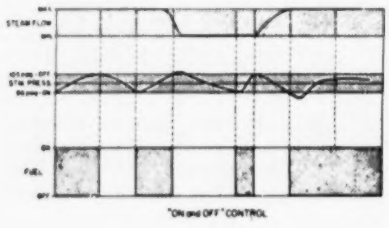


Fig. 1. On-off control, showing inherent cycling and effect of load change.

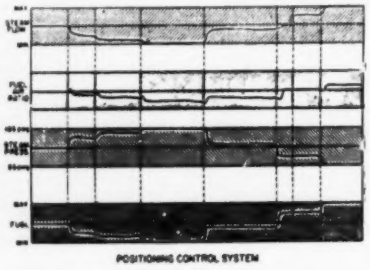


Fig. 2. Positioning control system in which steam pressure controls fuel flow.

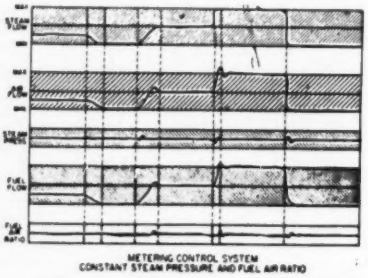


Fig. 3. Metering system in which fuel flow is measured and used to maintain constant fuel-air ratio, as well as constant steam pressure.

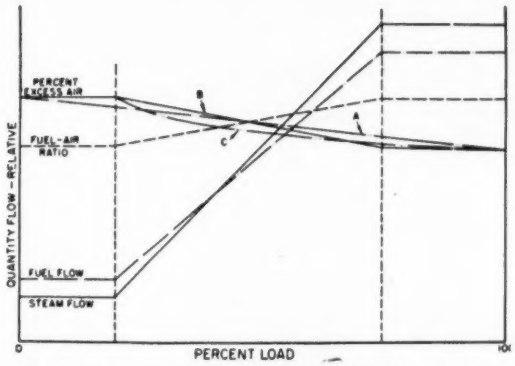


Fig. 4. Curves of steam flow, air flow, fuel-air ratios, and percent excess air, plotted against load.

There are many variations of the method as described, but basically the control system merely turns the fuel and air on and off through a predetermined steam-pressure range.

The curves in Fig. 1 reveal the inadequacies of the system. The steam pressure range determines the frequency of the "on and off," or cycling time. If the steam-pressure variation is increased to range between 90 and 100 psig, the cycling time can be reduced, but at the expense of departures of steam pressure from the set point. Overshooting of the steam pressure, either above or below the normal range, may result either from a sharp increase in load during an "off" period, or from a sharp reduction in steam flow during the "on" period. During the "off" period, much of the heat in the boiler setting is lost up the stack and must be replaced during the firing period, in addition to the heat required for meeting the demand for steam output.

Modulating Control

A modulating type of control is commonly used when the size of the boiler unit or the cost of fuel points up the deficiencies of on-off control, and where the cost of the modulating-control system is less than the return from gain in thermal efficiency. This type of equipment varies the amount of fuel and combustion air supplied in accordance with load demand.

The simplest type of modulating control is a "positioning" system (Fig. 2), which uses changes in steam header pressure to actuate both the fuel and air controlling units. The fuel valve and either the blower speed or the blower damper are positioned in proportion to changes in steam pressure.

It is theoretically possible to maintain a predetermined ratio of fuel and air for all load variations, provided that, for each load change, the fuel valve and blower damper are positioned accurately, and that all basic pressures and temperatures for fuel and air are maintained. The fuel-air ratio may deviate (Fig. 2) as the action of the fuel valve and the damper operating mechanisms becomes less exact.

Metering Systems

The fuel-air ratio determines the optimum thermal efficiency of a boiler. The ideal procedure, therefore, is to measure the actual flow rates of fuel and combustion air, and to maintain the desired fuel-air ratio. This is known as a metering-type control system.

The initial cost of the combustion-control system is a prime factor. Metering-type systems can become complicated, and the ultimate selection of the system may be a compromise between a positioning system and the metering of either the fuel or the combustion air. The metered signal is then used to maintain the desired fuel-air ratio, as shown in Fig. 3.

November Meeting: Thursday, the 18th, Rio Hondo Country Club, Downey, Calif.

Feature: "Measurement and Control In A Gasoline Plant" presented by Melroy C. Welch, Sunray Oil Corp.

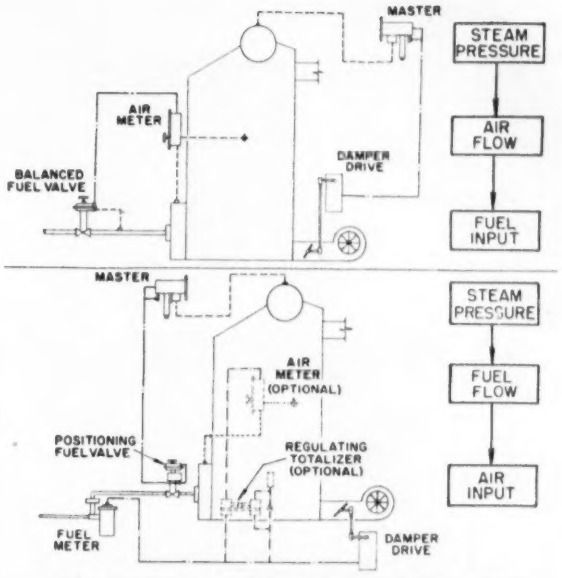


Fig. 5. Series control systems. Top, steam pressure controls air flow, which in turn controls fuel flow. Bottom, steam pressure controls fuel flow, which in turn controls air flow.

Fuel-air Ratio

The fuel-air ratio may vary for different loads. For example, the wide-range firing of boilers requires a higher percentage of excess air at low firing rates than is required at higher loads. In a simple control system the excess-air curve is a sloping line, as in curve "A" of Fig. 4. As the control system becomes more complicated it is possible to obtain the ideal fuel-air ratio by following a curve of excess air as indicated by line "B" in Fig. 4. The fuel-air ratio required for a boiler operating over a wide load range is shown as line "C."

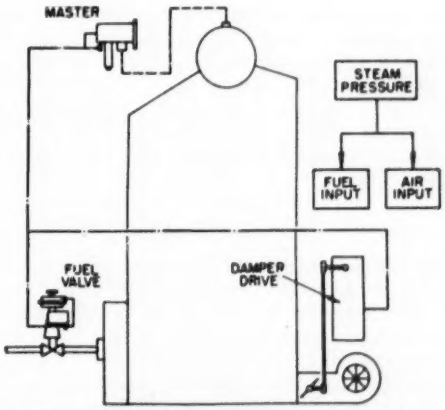


Fig. 6. Parallel control system in which fuel and air are controlled simultaneously by steam pressure.

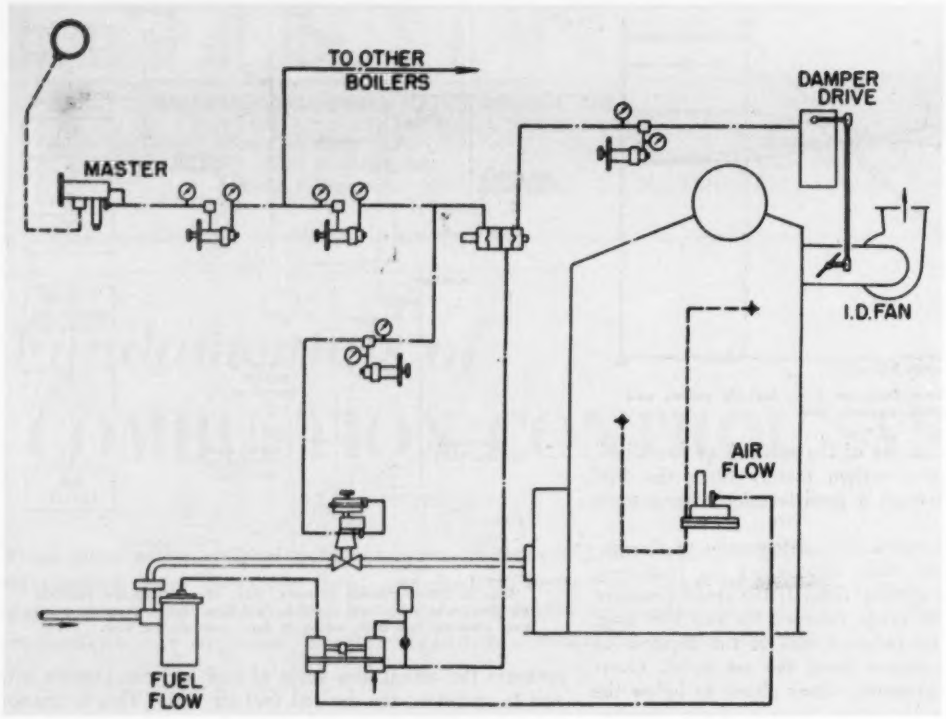


Fig. 7. Modified parallel system, in which fuel-air-ratio signal is used as corrective signal.

In order to obtain these various ratios of fuel and air with wide load range, it becomes necessary to examine the various metering controls and the combined systems, with their applications to various types of boilers.

In the simplest form, metering systems may be classified as series systems, parallel systems, and some combination of these two types, commonly styled a series-parallel system.

Series Systems

The two variations of series systems are shown in Fig. 5. In the first, steam pressure controls the air flow, and a measurement of the air flow then is used to control the input of fuel. Fuel pressure at the burners is generally taken as an index of the rate of fuel flow.

The second method is to control the fuel flow from steam pressure, and to control the input of combustion air from a metering indication of the fuel input. The air pressure in the burner windbox is commonly used as the index of combustion air supplied.

A comparison of these two methods indicates that the first method has the advantage of satisfying the air requirements before the fuel is supplied to the burners. A failure of the combustion-air supply automatically reduces the fuel input. During an increase in load, the air flow leads the fuel supply and insures adequate excess air for combustion.

Parallel System

In the parallel system, the combustion air and fuel are adjusted simultaneously in accordance with the steam header pressure (Fig. 6). When the parallel system uses positioning-type equipment only, it is usually necessary to characterize the movements of the fuel valve and the blower damper to secure the desired fuel-air ratio.

Modifications of the parallel positioning system are shown in Fig. 7. The air flow and fuel flow are matched, and the deviation from the desired fuel-air ratio is used as a corrective signal for either the air or the fuel. It is usually considered practical to use the fuel-burner pressure as an index of fuel flow.

Use of Steam Flow

Many control systems use steam flow as an index of load demand. The series metering system in Fig. 8 utilizes the steam pressure as a master signal to control fuel flow; the resultant steam flow is used to control the combustion-air supply. This system is normally used only when steam flow has narrow load fluctuations. An increase in steam flow demand results in an increase in air flow and a temporary decrease in steam pressure, which in turn calls for an increase in fuel flow. A decrease in the steam load causes the reverse action to take place. Provision is normally included in the automatic combustion-control system to prevent a total loss of combustion air as the result of a sudden decrease in steam flow.

Although the metering system just described is somewhat limited in its use, it introduces an important relationship between steam flow and the requirement for combustion air. The amount of combustion air required varies proportionately with the steam load. This is particularly true over the full load range of the boiler when the efficiency of the boiler is substantially constant and when a constant fuel-air ratio is to be maintained. The recording meter for steam flow and air flow may be calibrated to indicate an excess of deficiency of combustion-air supply, and departures from the set relation may be utilized for corrective purposes.

Alternative applications of this principle in a series-type system are shown in Fig. 9. Similar applications to the parallel-type system are shown in Fig. 10.

The systems described are fundamental, and are used generally for all sizes and types of boilers.

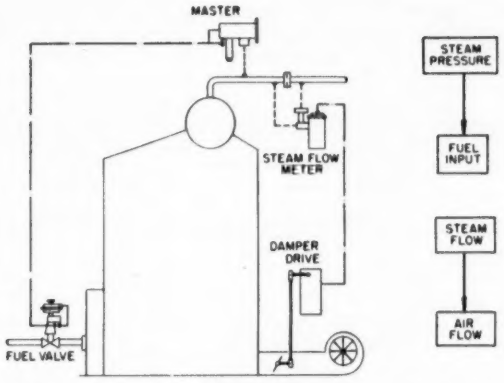


Fig. 8. Calorimeter series system in which steam pressure controls fuel flow; but load demand (steam flow) controls air flow.

The Control System

As the capacity, steam pressure, and steam temperature of boiler units increase, the corresponding automatic combustion-control systems must be more exact in speed of response and accuracy of control. The demand for constant steam pressure and temperature at the turbine throttle does not permit more than minor fluctuations in either steam pressure or superheated-steam temperature.

In all control systems—electrical, hydraulic, or pneumatic—changes in the steam header pressure are sensed by the master control element, and are converted into a signal. A typical pneumatic master-control unit is shown in Fig. 11, together with its characteristic air loading (signal pressure) curve for an established pressure gradient (proportional band) in the range of 445 to 455 psig. The curve is linear for a signal pressure which varies between 0 to 60 psig.; each pound of change in the steam pressure causes a change of 6 psi. in the signal pressure.

As the proportional band is decreased, the slope of the curve is decreased, as shown by the dotted curve in Fig. 11. A smaller change in steam pressure is required for a given change in signal pressure. This can, under some conditions, cause the controller to become unstable.

A wide proportional band requires a greater change in the steam pressure to secure the proper correction of fuel input. This results in greater stability of the control system, although excessive proportional band tends to make the control system sluggish, and usually introduces excessive delay by requiring too large a change in steam pressure before fuel input is changed sufficiently to restore steam pressure to the desired point.

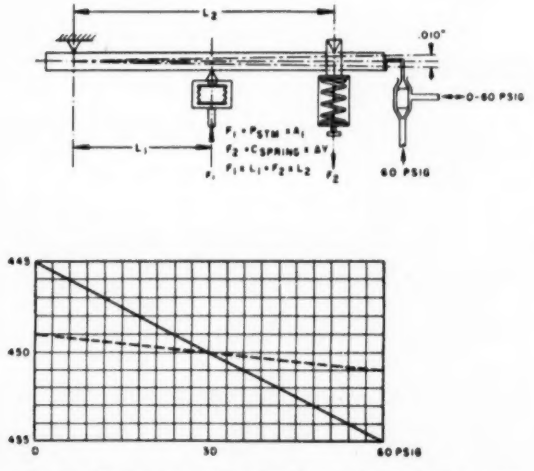


Fig. 11. Pneumatic master transmitter. Curves show two proportional bands.

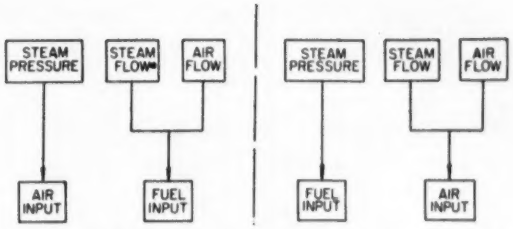


Fig. 9. Series-type system using steam flow to control fuel (left) or air (right).

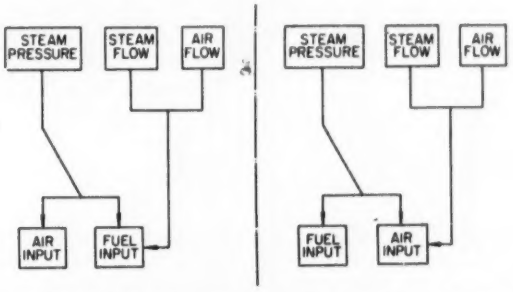


Fig. 10. Parallel-type systems in which both fuel and air are controlled by both steam pressure and load conditions.

For certain types of service, proportional control alone is not sufficient, particularly in the operation of steam turbines where wide fluctuations in throttle pressure can affect speed regulation. Such conditions require a modification of the master control to include both (1) a proportional-band-adjusting element and (2) a reset element. Such a master control is shown in Fig. 12.

The main bellows element (sensitive to steam header pressure) and the balancing spring are as in Fig. 11. The output signal (from the pilot valve) is connected to the proportional-band element (A) and to the reset element (B). An increase in the steam pressure above the set point raises the beam, the signal pressure from the pilot valve is increased, and is admitted to the proportional-band element to add to the downward spring force. The setting of the needle valve in the line to the reset element

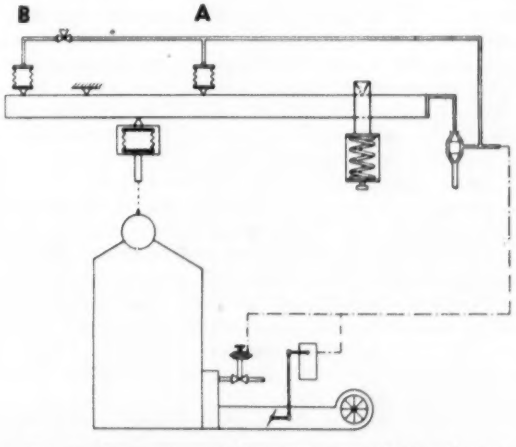


Fig. 12. Pneumatic controller with proportional and reset control actions.

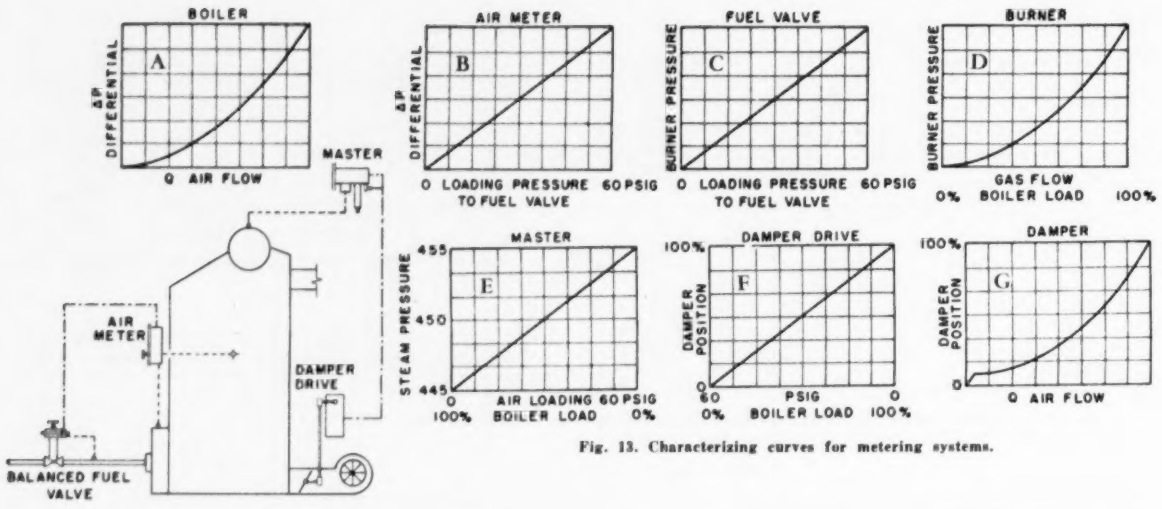


Fig. 13. Characterizing curves for metering systems.

allows this increasing signal pressure to reduce the effect of the proportional-band adjustment at a predetermined rate, and the fuel is reduced to restore steam pressure to the set point.

The reset element permits a constant steam-header pressure under diverse load conditions, while operating within a proportional band suited to the requirements for actuating the fuel valve and/or the fan damper drive unit.

Characterizing Curves

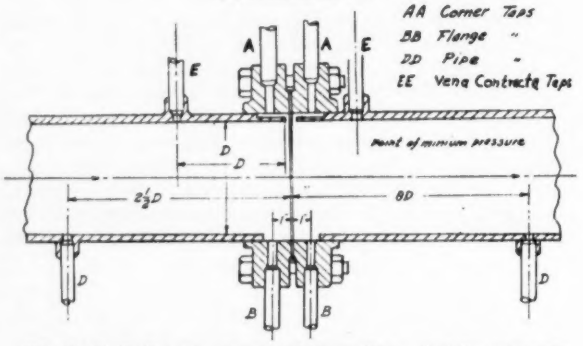
In a simple series system (Fig. 13) the master control actuates the fan damper drive, and the resulting air flow is used to dictate the fuel input. If the fan prime mover is a constant-speed electric motor or steam turbine, it often is desirable to characterize the action of the fan damper drive. This compensates for the fact that the angular travel of the damper required for a given change in air flow varies.

In Fig. 13, the air required for combustion, as a function of the fan damper position, is plotted against boiler load (curve F). These values were obtained by manual setting of the desired fuel-air ratio, and selecting the appropriate excess air for each boiler load condition as the result of flue-gas analyses and examination of the fire in the furnace. Curves of changes in steam pressure are plotted against changes in boiler load (curve E), and changes in boiler load are plotted against damper position (curve F). It is then necessary to measure the combustion-air flow differential, either across the boiler passages or across the burner windbox. Alternatively, a similar measurement can be made in a Venturi section installed in the air-duct system leading to the burners. The relation between the differential in the combustion-air supply system and the rate of air flow is well defined (curve A), and a meter is used to convert this differential into an air signal pressure for actuating the fuel valve in the proper relation to the air flow. The desired fuel-air ratio for a given load determines the amount of fuel necessary, and for a particular burner design, the fuel pressure at the burner determines the quantity of fuel fired. This fuel pressure is used to balance the air signal which actuates the fuel control valve, and this valve continues to position itself until the fuel pressure matches the signal transmitted from the air metering unit.

The curves in Fig. 13 illustrate these conditions. Gas input is plotted against burner pressure (curve D), burner pressure is plotted against air signal pressure to the fuel valve (curve C), and combustion-air differential is plotted against air signal pressure required for actuating the fuel control valve (curve B).

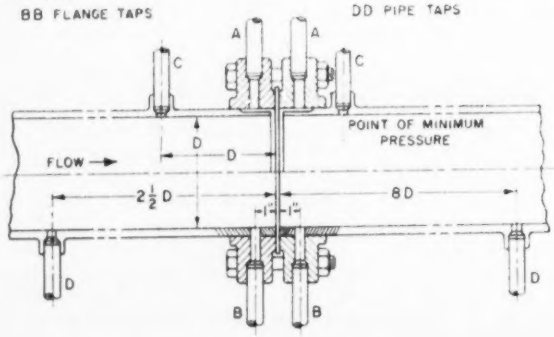
Fuel-burner characteristics vary with different designs. Fuel flow through the burners may be linear with pressure, as in many oil burners, or may vary as a square function, as in most gas burners. There are many fuel burners which follow no particular pattern. The meter measuring combustion-air differential must be characterized to transmit the signal to the fuel valve which can result in the correct fuel pressure to satisfy both the heat-input requirements and the fuel-air-ratio requirements.

CORRECTION



Mr. W. K. Dudley, Jr., Creole Petroleum Corp., Caripito, Venezuela, informs us that an error exists in the flange-tap portion of the illustration above (Fig. 1 in the article "Flowmeter Engineering" in the May issue of the SCMA Journal).

Mr. Spink (one of the authors) submits the corrected drawing below. Correction is shown by shaded pipe through which the flange taps are connected.



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Briefs . . .

Instruments and AUTOMATION

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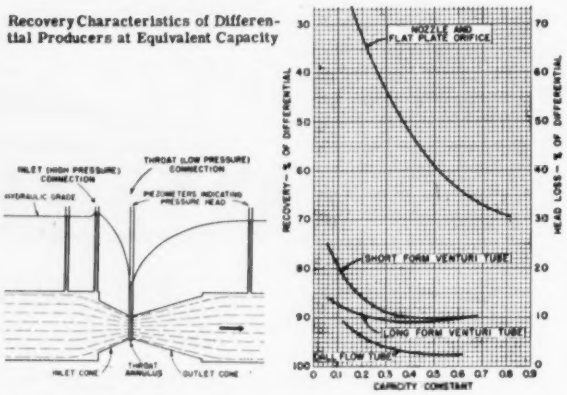
measured variable	medium	range min	range max	units	mechanism
conductivity	liquids	as required		μmhos	electrolytic cell
differential	gases	0-0.45	0-50	"H_2O	diaphragm
	gases	0-2.3	0-57.2	"H_2O	manometer
	gases	0-13.5	0-431.8	"H_2O	float, hg seal
	gases	0-54	0-215.9	"H_2O	float, hg seal
	liquids	0-12.5	0-1200	"H_2O	bellows
	liquids	0-12.5	0-400	"H_2O	float, hg seal
	liquids	0-200	0-1200	"H_2O	float, hg seal
gas analysis	oxygen	0-5	0-25	%	catalytic combustion
	combustibles	0-5	0-25	%	
	O_2 and comb.	0-5	0-25	%	
	gas mixture ratio	as required		%	resistance filament
smoke density	smoke	varies	100	%	bolometer
specific gravity	liquids	as required			bubbler-system
speed	rotary and linear	135	5000	rpm	tachometer generator
temperature	solids, liquids, and gases	−310	1200	°F	resist element
		0-200	0-1200	°F	gas filled
		0-300	0-1000	°F	gas filled
		0-1500	0-3000	°F	thermocouple
		1500	5000	°F	radiation
vacuum	gases	−.5 to 0	−55 to 0	"H_2O	diaphragm
	gases	−10 to 0	−30 to 0	"Hg	bellows

(*From new* 16*-page Bulletin* 17*-F, "Meters and Controls for the Process Industries," Bailey Meter Co., Cleveland* 10*, Ohio.*)

For this literature circle **401** on inquiry card.

Recovery Characteristics of Differential Producers at Equivalent Capacity



Dall Flow Tubes

Horace E. Dall, Chief Engineer of George Kent, Ltd., . . . developed an accurate primary device having less permanent head loss than any known type of velocity-increasing differential producer. . . . The Dall flow tube consists of a flanged cylindrical body designed with a short, straight inlet section terminating with an abrupt decrease in diameter, or "inlet shoulder", which is followed by a conical restriction and a diverging outlet separated by a narrow annular gap called the "slotted throat annulus".

To obtain fair comparison of the losses caused by various differential producers, it is necessary to examine sizes which produce the same differential pressure for the same rate of flow. Such a comparison is obtained by plotting the percent head loss versus a "capacity constant". . . . On this basis, the Dall Flow Tube shows the lowest permanent head loss of any standard differential producer. (*From new* 16*-page Technical Bulletin* 115*-L3, Builders-Providence,* 422 *Harris Ave., Providence* 1*, R.* I.)

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Reversing Fractional-horsepower Motors

(*From new* 4*-page issue, Vol.* 34 *No.* 4*, of "Motorgram," Bodine Electric Co.,* 2250 *W. Ohio St., Chicago* 12*, Ill.*)

For this literature circle **403** on inquiry card.

Features of Fractional Horsepower Reversing Motors

Fractional Horsepower Motors From 1/2000 Hp to ¼ Hp	Induction Type Reversing Motor: Split Phase* Non-Synch.	Split Phase* Synch.	Capacitor Start & Run: Non-Synch. 4-Lead Rev.	Non-Synch. 3-Lead Rev.	Synch. 4-Lead Rev.	Synch. 3-Lead Rev.	Multiphase Non-Synch.	Multiphase Synch.	Brush Type Reversing Motor: Shunt Motor Full Field	Shunt Motor Split-Field	Compound Motor 5-Lead Reversible	Series Motor** 4-Lead Rev.	Series Motor** 3-Lead Rev.
Suitable for reversing at rest only	X	X											
Suitable for reversing during rotation or at rest			X	X	X	X	X	X	X	X	X	X	X
Double-pole double-throw switch required	X	X	X		X		X	X	X		X	X	
Single-pole double-throw switch sufficient**				X		X				X			X
Running characteristics slightly affected by best obtainable instantaneous reversing characteristics							X	X	X		X	X	
Running characteristics greatly affected by best obtainable instantaneous reversing characteristics			X	X	X	X				X			X

* By the use of a special centrifugal switch, in addition to a 3 P.D.T. switch, split phase motors may be reversed during rotation.

** Instantaneous reversing is limited to low horsepower and low speed motors.

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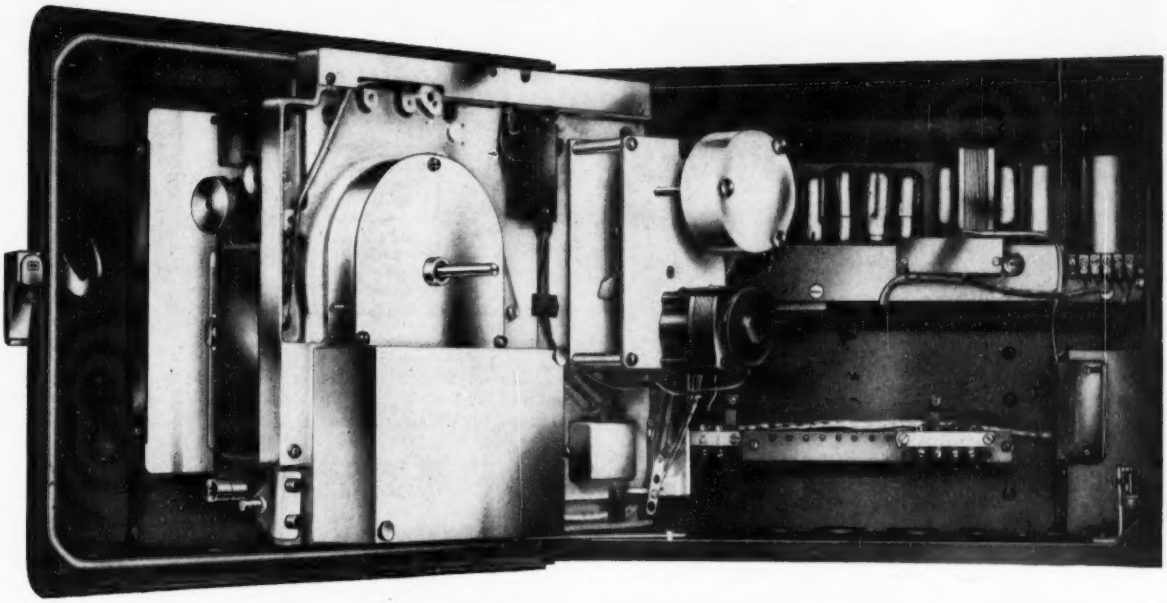

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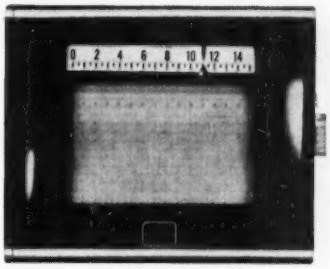
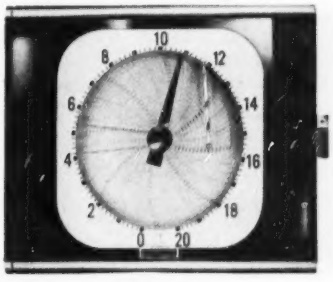


BRISTOL ELECTRONIC DYNAMASTERS are made in round- and strip-chart, single- and multiple-record recorders, air-operated and electric controllers (all types of control actions). Two-pen and Program Control.



BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

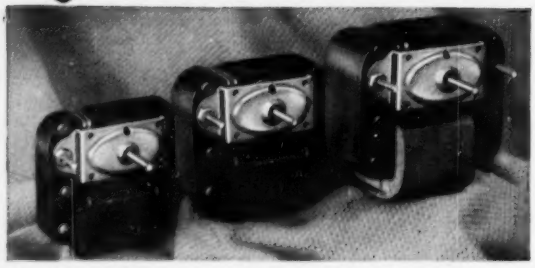
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **100** on inquiry card.

BARBER COLMAN

announces a new line of Barcol.

High Power Small Motors



Combining high starting torque with exceptional power output, the new Barcol YAF unidirectional motors meet the demands of products requiring components of highest quality. They are *extra*-powerful, *extra*-rugged to take on the tough jobs and stand up under long, hard duty. Available in three stack thicknesses . . . with nine power ratings from 1/200 to 1/40 hp . . . these advanced type motors provide a wide selection to match the exact needs of your applications. If you have a project calling for a compact motor with extra power, investigate this new Barcol line purposely developed to meet such requirements. Write for bulletin on Barcol YAF small motors.

BARBER-COLMAN COMPANY, DEPT. J, 1215 Rock St., ROCKFORD, ILL.

For more information circle **101** on inquiry card.

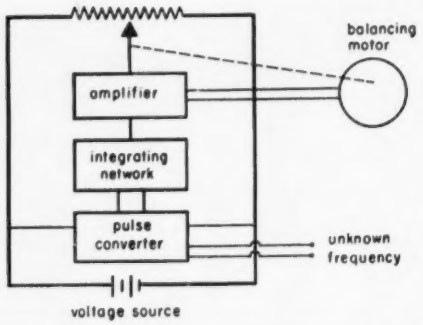
PROTECT
EXPENSIVE GAGES

SPRAGUE SHUT OFF VALVES automatically cut out gages and other pressure-sensitive instruments when fluid pressures go beyond their operating limits. Automatically open when pressure is again within approx. 80% of set cut-out points. Available for any pressure setting between 10 PSI. and 5000 PSI. Save valuable man hours. Eliminate opening and closing manually operated shut off valves. Supplied with standard pipe thread connections, also available with AN tube fittings. Body is 1½" aluminum hexagon stock. Length 5½". Bronze or stainless steel bodies also available. Easy to install. Thousands in use. Write for bulletin.

SPRAGUE
Engineering and Sales Corp.
1144 WEST 135TH STREET, GARDENA, CALIFORNIA

For more information circle **102** on inquiry card.

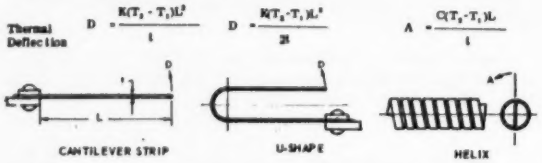
BRIEFS—CONTINUED



amplifier-motor combination which responds by driving the pen and slidewire contactor to the required null-balance position. (*From new 2-page Data Sheet 9.1-8a, Minneapolis-Honeywell, Ind. Div., Phila. 44, Pa.*)

For this literature circle **404** on inquiry card.

Thermostat Metal

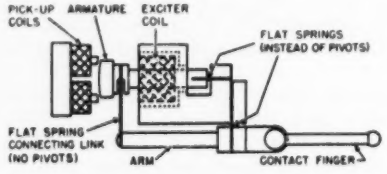


(*From new 6-page Technical Data Sheet No. 400, American Silver Co., 36-07 Prince St., Flushing 54, N. Y.*)

For this literature circle **405** on inquiry card.

Electronic Gage

In using this equipment, the gage head is positioned to give a zero reading at the desired dimension or work position. A meter on the amplifier (or a recorder) shows deviations in work size or position, either side of zero . . . .all Cleveland gage heads contain an exciter coil, two pickup



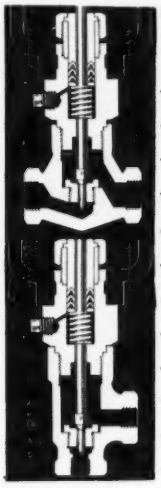
coils and an armature. The exciter coil and pickup coils are in fixed position, while the armature moves with the gage head stem or contact finger.

The exciter coil sets up an alternating magnetic field in the armature; and this, in turn, induces a voltage in the pickup coils. The pickup coils are so connected that the voltages induced in them are 180° out of phase; and the *difference* in the voltages induced in the two pickup coils is directly proportional to the distance of the armature from central or zero position. This differential voltage goes to the amplifier; and the amplifier meter (or recorder) shows both the *amount* and the *direction* (either side of zero) of the displacement of the armature from zero position. . . . The Indi-Ac gage head permits readings to 0.000010 in.; the Par-Ac to 0.000010 in.; the Micro-Ac to 0.0000005 in. or 0.000001 in. (*From new 12-page Bulletin 542, Cleveland Instrument Co., 735 Carnegie Ave., Cleveland 15, Ohio.*)

For this literature circle **406** on inquiry card.

Needle-type Control Valves

Needle type (valve) is designed for the integrated pneumatic control system where precise control of low rates of flow is necessary. . . . The C_v's . . . are the capacity of the

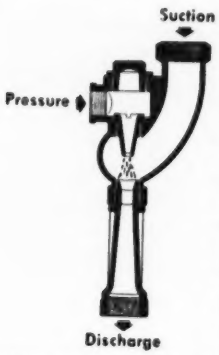


NEEDLE SIZE	C_v
.017	.0026
.024	.0052
.037	.012
1/16"	.04
1/8"	.14
3/16"	.32
1/4"	.56
3/8"	1.27
1/2"	2.25
5/8"	3.5
3/4"	5.1
7/8"	6.9

valve in GPM of H_2O with 1.0-psi. pressure drop and the valve wide open . . . . each provide a rangeability of 35:1. (*From new 8-page Bulletin 5C-13, Foxboro Co., Foxboro, Mass.*)

For this literature circle **407** on inquiry card.

Water Jet Eductors



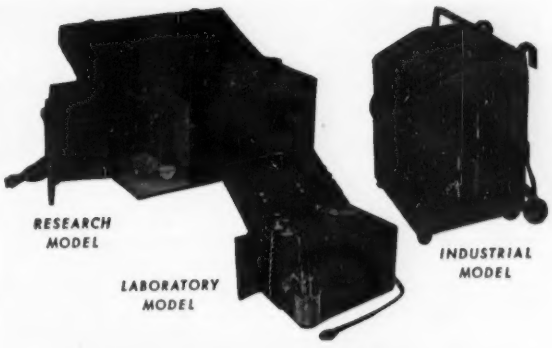
Water Jet Eductors operate on the jet principle utilizing the kinetic energy of one liquid to cause the flow of another. The pressure liquid, usually water, discharges at high velocity through a converging nozzle and entrains the suction liquid. The two liquids, intimately mixed in the diffuser of the eductor, are discharged against a counter pressure. . . . Applications include the lifting, pumping, mixing and agitating of liquids and the handling of solids and slurries. Features include light weight, no moving parts, little maintenance. (*From new 36-page Bulletin 2 M, Schutte & Koerting Co., Cornwells Heights, Bucks County, Pa.*)

For this literature circle **408** on inquiry card.

Hot Wire Anemometers

A hot wire anemometer is an instrument which makes possible the study of velocities in moving fluids by using the cooling effect of the stream on a thin electrically-heated metal filament. A complete single-channel system for the measurement of average velocity and velocity fluctuations consists of a probe to hold the hot wire in the fluid stream, a controlled current source for electrically heating the wire, equipment for measuring precise d/c electrical values, and an amplifier and recording device for measuring a/c electrical signals.

Two types of hot-wire system are in general use for velocity fluctuation measurements. In the constant-current system the heating current is kept constant and the variations in wire resistance (i.e., in wire voltage) are used as the measure of velocity. In the constant-resistance (i.e., constant-temperature) system the heating current is



Cambridge pH Meters

The three portable models illustrated above incorporate new and important advantages. A.C. line operation eliminates battery nuisance. Laboratory and Research models use electron-ray tube for precise null-point indication. Industrial model is direct-reading, continuous-indicating; ruggedly built for plant use.

Accuracy: Research .02 pH, Laboratory .05 pH, Industrial .10 pH, Cambridge pH equipment also includes single- and multi-point indicators and recorders. Send for Bulletin 910-MR.

CAMBRIDGE INSTRUMENT COMPANY, INC.
3742 GRAND CENTRAL TERMINAL, NEW YORK 17, N. Y.

Pioneer Manufacturers of
PRECISION INSTRUMENTS

For more information circle **103** on inquiry card.

Linde **synthetic sapphire**
...for excellent optical transmission
PLUS physical strength and chemical inertness

Sapphire is hard, strong, chemically inert and transmits a high percentage of radiation in the important ultra-violet and infra-red regions. At 1750A forty per cent of the radiation is transmitted by a .059 inch section; at 5.7 microns forty per cent is transmitted by a .100 inch section. This unique combination of properties makes it ideal for optical systems that require resistance to abrasion and corrosion and high temperature strength as well as excellent optical transmission.

Now single-crystal sapphire windows are available in diameters up to 2 inches in several finishes. For further information, call or write your nearest LINDE office.

LINDE AIR PRODUCTS COMPANY
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For more information circle **104** on inquiry card.

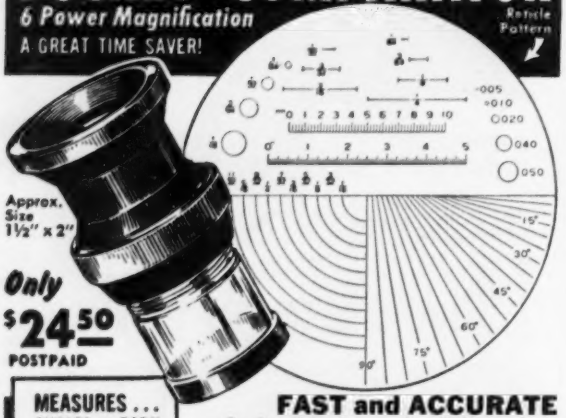
CHECK, MEASURE, INSPECT with this HANDY

POCKET COMPARATOR

6 Power Magnification

A GREAT TIME SAVER!

Reticle Pattern



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MEASURES . . .
ANGLES • RADII
CIRCLES
LINEAR
DIMENSIONS
in both decimal inches and mms.

FAST and ACCURATE
On Small Parts . . . Small Dimensions

First time available at such low price! EDSCORP POCKET COMPARATOR. Fine, imported measuring magnifier—for fast, accurate inspections. Black anodized metal cell. Clear plastic base. Focusing adjustment. Used to check layouts, machining on tools, dies, gauges—to check threads, chamfers, small holes. In optical work for checking flaws. Instrument comes in protective leather case. We guarantee complete satisfaction or your money back . . .

Order Stock No. 30,061-AM . . . $24.50 postpaid. Send check or M.O. or order on open account.

Dealer Inquiries Invited

SPECTRAL LAMPS (famous German Osram Series)

Used in instruments requiring a monochromatic light source or a segment of the spectrum. All lamps fit a standard medium prefocus socket. Supply voltage: 220 A.C. Amperage: 1.0 to 1.5.

Stock No.	VAPOR	Price Pstpd.	Stock No.	VAPOR	Price Pstpd.
50,054-AM—	Cadmium	$29.20	50,060-AM—	Sodium	$29.20
50,055-AM—	Cesium	29.20	50,061-AM—	Neon	29.20
50,056-AM—	Helium	29.20	50,062-AM—	Rubidium	29.20
50,057-AM—	Mercury	29.20	50,063-AM—	Thallium	29.20
50,058-AM—	Mercury Cadmium	32.50	50,064-AM—	Zinc	29.20
50,059-AM—	Potassium	29.20	50,065-AM—	Mercury Sulphide	38.48

EDMUND SCIENTIFIC CORP., Barrington, N. J.

For more information circle **105** on inquiry card.

These CEC miniature precision instrument-type

pressure pickups

cover a wide performance range

Consolidated pressure pickups feature a-c or d-c excitation—full-scale pressure ranges from 5 to 5,000 PSI—linearity within 1%—negligible sensitivity to acceleration and vibration—wide temperature range from −65°F to +250°F—output 20 millivolts with 5-volt excitation—flush-type diaphragm as standard construction—stainless steel, corrosion-resistant construction—overload protection—high frequency response—variable-resistance types—calibration certificate with each pickup. Electrical principle is unbonded strain-gage windings connected in a four-arm bridge as the active element. Write for Bulletin CEC 1552-X1 and price list.

Pickup Type	*Range*	*Dimensions*
4-310 gage pressure pickup	5 to 250 PSI	0.5" diam. x 0.7"
4-311 gage pressure pickup	5 to 5,000 PSI	0.625" diam x 0.875"
4-312 absolute, differential, or gage pressure pickup	5 to 250 PSI	0.5" diam x 0.7"

Consolidated Engineering
CORPORATION
300 North Sierra Madre Villa, Pasadena 15, California

For more information circle **106** on inquiry card.

automatically varied so as to maintain the wire resistance constant, the current then being the measure of velocity. The constant resistance system has a theoretical advantage in that large-scale slow fluctuations in no way alter the response of the system to high frequency fluctuations. . . . The constant current system is simpler, offers better resolution and is less expensive. (*From new 4-page brochure, "Model HWB," Flow Corporation, 283 Concord Ave., Cambridge 38, Mass.*)

For this literature circle **409** on inquiry card.

Luminosity Calibration

(For) accurate calibration of measurement apparatus, and if low luminous intensity is involved, it has become standard practice to specify radioactive self-luminous standards for calibration purposes.

USEFUL RADIOISOTOPES

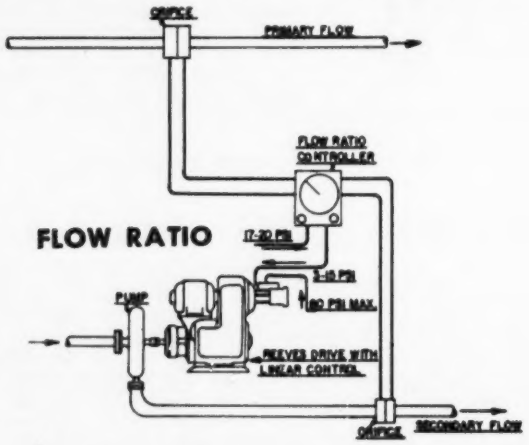
RADIOISOTOPE	HALF-LIFE YEARS	BETA RAY ENERGY MEV-MAX
Tritium (H3)	12.4	0.0189
Carbon 14 (C14)	5720	0.155
Cesium-Barium 137 (Cs 137-Ba137)	37	1.2 0.51
Promethium 147 (Pm 147)	2.3	0.223
Strontium-Yttrium 90 (Sr 90-Yt 90)	25	0.537 2.18
Thallium 204 (Tl 204)	2.7	0.783

The recent development by the U. S. Radium Corporation of a new series of "Isolite" light standards incorporating radioisotope-activated phosphors as the light source permits the selection of color-matched high constancy calibration units. The table lists the potentially useful (beta-emitter isotopes). (*From new 4-page issue Vol. 1, No. 2, "Radiations," U. S. Radium Corp., 535 Pearl St., New York 7, N. Y.*

For this literature circle **410** on inquiry card.

Pneumatic-controlled Motor Drive

Control manufacturers have established a standard range of 3 to 15 psi. air signal to represent change in process. . . . The "Auto-Pneumatic" control is a valve positioner and



pneumatic piston that is connected to the speed-shifting mechanism of the "Vari-Speed Motodrive". . . . Each minute change in instrument air pressure actuates an increment of rpm. change on the "Motodrive" output shaft. (*From new 6-page Bulletin M-542, Reeves Pulley Co., 1015 N. Wilson St., Columbus, Ind.*)

For this literature circle **411** on inquiry card.

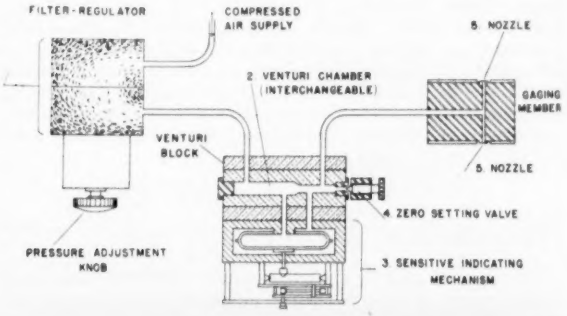
Variable-area Flowmeters

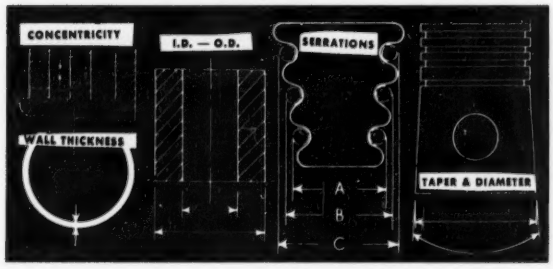
The Spool Type Float and the precision-molded, transparent metering tube with Inner-Wall Guides are an exclusive and patented development of CRL. . . . For research, development, and exacting production flow inspection, flowmeters are furnished in a flexible housing which permits combining any desired number of metering elements in series in a single case. This "Multiple-Stage" design thus permits covering a wide flow range in a compact instrument. . . . For industrial applications the metering element offers the additional features of float visibility with opaque fluids. (*From new 28-page Complete Flowmeter Catalog, Commercial Research Laboratories, Inc., 20 Bartlett Ave., Detroit 3, Mich.*)

For this literature circle **412** on inquiry card.

Velocity-type Air Gage

Because of its *velocity-type* circuit, which requires virtually no build-up in back pressure, a Taft-Peirce Comp-AIRator measures instantaneously without flutter or creep.





There is virtually no time lag in obtaining readings. . . . As the air flows through the Venturi chamber, its velocity creates a pressure differential . . . . which is transferred to the dial. . . . Magnifications are 5000 to 1, 2500 to 1, 1650 to 1, 1250 to 1, and 625 to 1. (*From new 30-page Catalog 613, The Taft-Peirce Mfg. Co., Woonsocket, R. I.*)

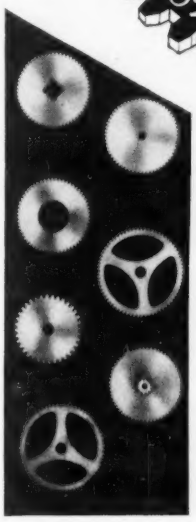
For this literature circle **413** on inquiry card.

Dynamic Pressure Transducers

The calculation of the natural frequency and the damping ratio of a liquid-filled line plus transducer system is usually very difficult. Even in a simplified analysis, it is necessary to know precisely the parameters of the pressure transducer and the liquid connections. The parameters of the liquid connections (i.e., density, temperature, viscosity, diameter and length of tube, elasticity of tube wall, etc.) are usually known or easily determined. However, the parameters of the transducer (i.e., spring constant, effective area of the sensing element, mass of moving components, volumetric displacement of sensing element, etc.) may be unknown and difficult to obtain.

A method, based on static measurement, will be presented whereby reasonably accurate predictions may be calculated concerning the dynamic response of a liquid-

WINZELER
Stamped Gears



SAVE . . They're Designed and Tooled to YOUR Needs!

You, too, can save assembly time and money with the *greater accuracy* of these better Stamped Gears! Critical buyers, near and far, are profiting from our skilful tooling, stamping and assembly methods. Cut costs . . step up production . . improve product performance. Specify Stamped Gears by WINZELER!

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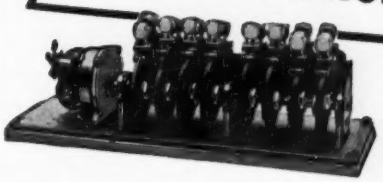
For more information circle **107** on inquiry card.

Automation is easy and inexpensive with

Staley Time Cycle Controllers



This Time Cycle Controller has controlled automatic operations continuously for periods as great as 9 years without mechanical failure.

● Now you can stop and start motors, open and close relays, doors, gates, valves—completely automatically at any predetermined cycle of time interval—*without expensive and complicated time delays!* Staley Time Cycle Controllers give you accurate, dependable, trouble-free automatic control for electric circuit operations of all kinds from 1 to 110 circuits. Lightweight, rugged design. Use of Staley Metallic Mercury Switches assures positive contact, ample power for long periods of uninterrupted service. Write today for complete information.

ELECTRIC SWITCH CORPORATION
1306 E. ELEVENTH STREET • COLUMBUS, INDIANA

For more information circle **108** on inquiry card.

How's your technical library?
Check this list.

Electronic circuitry for Instruments and Equipment by Milton H. Aronson, 1953, cloth, 310 pages. Price $4.00 ☐

Scientific and Industrial Glass Blowing and Laboratory Techniques by W. E. Barr and Victor J. Anborn, 1949, 4½" x 8", 388 pages. Price $6.00 ☐

The Electronic Control Handbook by R. R. Batcher & Wm. Moulic, 1952, paper, 244 pages Price $3.00 ☐

Heat Inertia Problems of Automatic Control of Temperature by Victor Brodia, 1950, paper, 5¼" x 8¼", 61 pages. Price $1.00 ☐

Applications of Industrial pH Controls by Allen L. Chaplin, 1950, cloth, 4½" x 8", 144 pages. Price $2.50 ☐

Maintenance and Servicing of Electrical Instruments by James Spencer, Third Edition 1951, cloth, 4¾" x 8¼", 256 pages. Price $3.00 ☐

Mechanical Measurements by Electrical Methods by Howard C. Roberts, Second Edition 1951, cloth, 4¾" x 8¼", 537 pages. Price $4.00 ☐

Operation and Care of Circular-scale Instruments by James Spencer, 1949, cloth, 4½" x 8", 90 pages. Price $1.50 ☐

Instrumentation for the Process Industries (Proceedings Eighth Annual Symposium on Instrumentation for the Process Industries, School of Engineering, Agricultural and Mechanical College of Texas) 1954, 8" x 11¼", 36 pages. Price $2.00 ☐

Instrumentation for the Process Industries (Seventh Symposium) 1953, 8" x 11¼", 68 pages. Price $2.00 ☐

Instrumentation for the Process Industries (Sixth Symposium) 1952, paper, 8" x 11¼", 64 pages. Price $2.50 ☐

Instrumentation for the Process Industries (Fifth Symposium) 1951, paper, 8" x 11¼", 56 pages. Price $2.50 ☐

Guide to Foreign Sources of Metallurgical Literature by John T. Milek, 1951, paper, 8½" x 11", 108 pages. Price $2.50 ☐

A Romance in Research—The Life of C. F. Burgess by A. McQueen with Technical Appendix by O. W. Storey, 1951, cloth, 6" x 9", 430 pages. Price $6.00 ☐

Stress Corrosion of Mild Steel by James T. Waber & Hugh J. McDonald, 1947, paper, 5¾" x 8¾". vi+ 94 pages. Price $2.00 ☐

Instrumentation for the Iron & Steel Industry (Proceedings Third Annual Conference on Instrumentation for the Iron & Steel Industry, Carnegie Institute of Technology and the Pittsburgh Section, Instrument Society of America) 1954, paper, 8" x 11¼". Price $2.00 ☐

Instrumentation for the Iron & Steel Industry (Proceedings of Second Conference) 1953, paper 8" x 11¼". Price $2.00 ☐

Instrumentation for the Iron & Steel Industry (Proceedings of First Conference) 1951, paper, 8" x 11¼", 52 pages. Price $2.00 ☐

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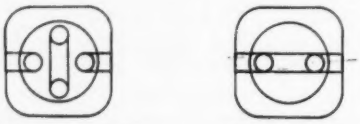
BRIEFS—CONTINUED

filled system which is constrained to a single degree of freedom. (*From new 8-page issue No. 27, "Instrument Notes," Statham Labs., 12401 W. Olympic Blvd., Los Angeles 64, Calif.*)

For this literature circle **414** on inquiry card.

Hydraulic and Pneumatic Valves

The patented "Shear-Seal" principle consists primarily of a pressure balanced, self-aligning, tubular valve seat, the "Shear-Seal," constantly in perfect contact with an optically flat porting disc or rotor containing flow pas-



sages. These various flow passages are oriented by rotation of the rotor. Mating surfaces of the "Shear-Seals" and rotor are lapped to a five micro inch finish and checked with monochromatic light waves to assure optical flatness within one light band per inch. (*From new 36-page Catalog 4 G, covering manual valves, solenoid valves, pilot valves, and pressure switches, Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.*)

For this literature circle **415** on inquiry card.

Recording Paper

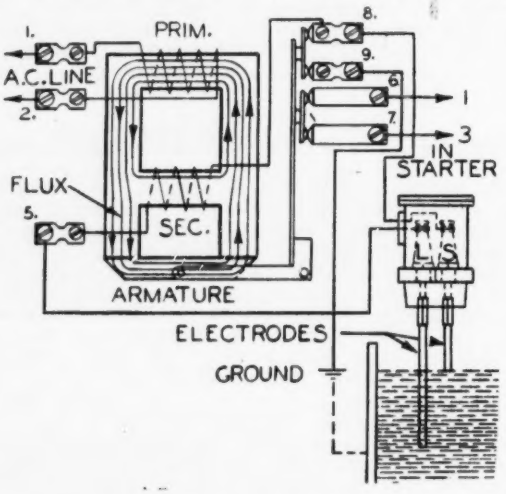
The simple principle on which the "Waxon" recording system works is this: A colored paper stock is coated on one side with a lighter colored opaque wax of such a nature that when pressure is applied to it it becomes transparent throughout the area of such pressure, permitting the color of the basic paper stock to show through . . . . any hard-pointed object moving over the coated surface would make the wax transparent along its path. (*From new 4-page brochure, Waxon-Carboff, Inc., Rochester, N. Y.*)

For this literature circle **416** on inquiry card.

Floatless Level Control

B/W floatless liquid-level controls are suited for control of any liquid which is a conductor of electricity . . . for pumping or valving operations.

When a source of alternating current is connected to the primary coil at terminals 1 and 2, the primary coil sets up a

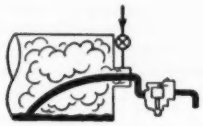


magnetic flux. The flow of magnetic flux induces a voltage in the secondary or electrode circuit coil. No current flows through this circuit unless it is closed. Thus, the electrode circuit current, being generated within the relay, has no connection with the power line. (*From new 40-page brochure, B/W Controller Corp., 2220 E. Maple Rd., Birmingham, Mich.*)

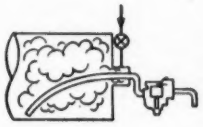
For this literature circle **417** on inquiry card.

Why Cylinders Waterlog

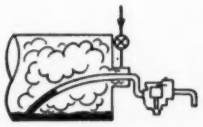
Most machines discharge into closed return systems and low output caused by intermittent waterlogging is often mistakenly accepted as "normal". . . . steam in syphon pipe



A. Condensate being discharged.



B. Condensate discharged. Syphon pipe fills with steam.



C. Cylinder waterlogs because condensate is blocked by steam lock in syphon pipe. Waterlogging continues until locked steam condenses.

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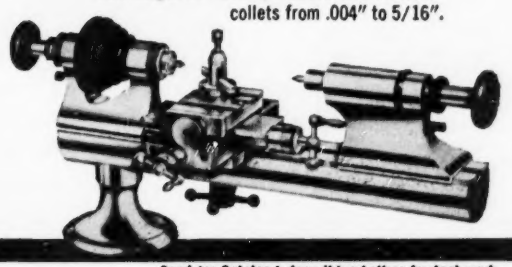

Send for Catalog L describing Lathes for tool work, second operations; turrets and full line of accessories.

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For more information circle **109** on inquiry card.

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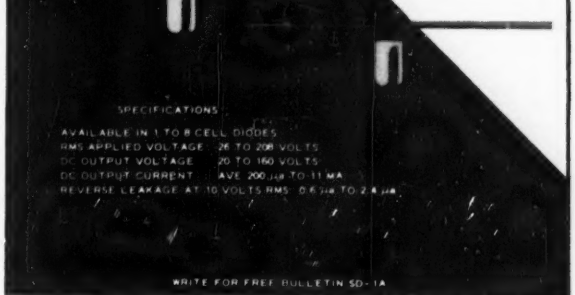

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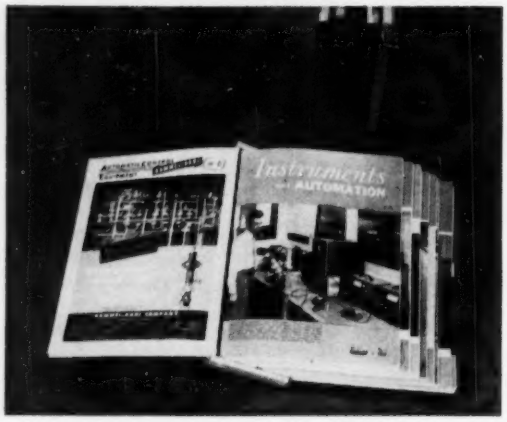

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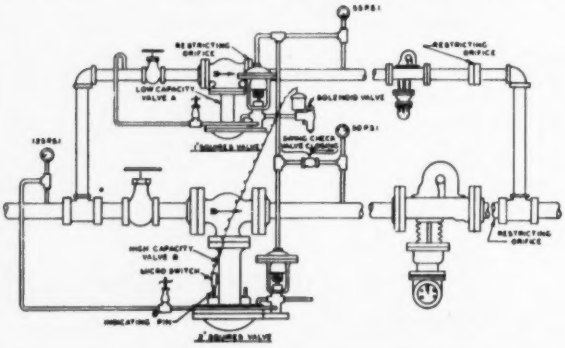
BRIEFS—CONTINUED

(often) blocks the passage of condensate to the trap. Until this steam lock slowly condenses, condensate collects and waterlogs the cylinders, causing low and erratic temperatures across the faces. (*From new 4-page Vol. 25, No. 5 issue of SARCO NEWS, Sarco Co., Inc., Empire State Bldg., New York 1, N. Y.*)

For this literature circle **418** on inquiry card.

Dual-range Flowmetering

Present flowmeters usually are restricted in accuracy to a range from 100 or 150 percent to 10 percent of rated capacity. Below this range they do not register the entire flow. As one method of approaching the problem of more accurate metering below the 10 percent rate, a system of utilizing two flowmeters and two pressure-reducing valves was installed and tested by the Ohio Edison Company, in



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For more information circle **112** on inquiry card.

conjunction with The C. E. Squires Company . . . The two valves were synchronized so that only one meter was in operation at any flow rate and instantaneous switchover took place. At 20 percent of maximum 2-in. valve capacity and below, this valve closed and the 1 in. opened. (*From 8-page reprint, Builders-Providence, Inc.,* 345 *Harris Ave., Providence, R. I.*)

For this literature circle **419** on inquiry card.

Process Monitor

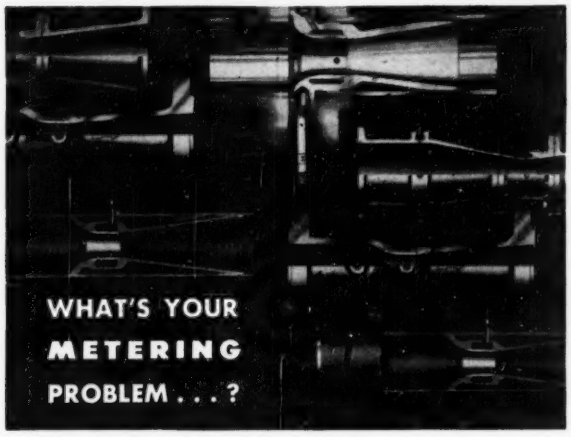
The Electro-Larm (annunciator) has four distinct key positions: (1) *Normal,* indicator key lamp darkened. (2) *Alarm* . . . indicator key automatically moves from "normal" position to "alarm" position and is illuminated . . . with attended sounding of an audible signal. (3) *Pending.* The operator upon being warned of an "Alarm" condition moves the key from "Alarm" to "Pending," silencing the audible signal, but the illumination of the key is maintained. (4) *Clear.* When the abnormal condition is corrected the key automatically moves to "Clear" again, sounding the audible signal. The operator may now move the key to "Normal," silencing the audible signal and darkening the key. (*From new 4-page brochure, Electro Devices, Inc.,* 4025 *Easton Ave., St. Louis* 13, *Mo.*)

For this literature circle **420** on inquiry card.

Edge-lighted Panels

An edge-lighted panel or dial is more than just a variable-intensity light source; existing specifications include (1) Light Level. (2) Uniformity of Lighting. (3) Character Size and Dimensions. (4) Contrast. (5) Reflection or Gloss. (6) Scratch Resistance. (7) Resistance to Humidity. (*From new 4-page issue Vol.* 1, *No.* 3 *issue of "Radiations," U. S. Radium Corp.,* 535 *Pearl St., New York* 7, *N. Y.*

For this literature circle **421** on inquiry card.



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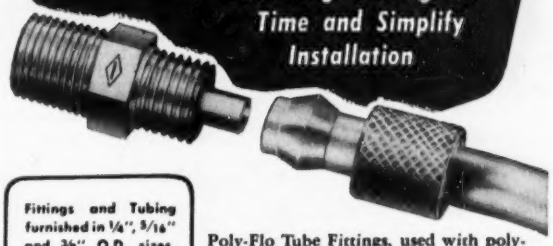

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MANUFACTURERS' NEW LITERATURE

In this department we report new literature, pertaining to instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on Page 1671.

Requests for literature FROM ABROAD should be made on company letterhead and mailed DIRECTLY to the manufacturers.

AUTOMATION

Card-programmed Management: New 28-page illustrated Booklet 32-5608-1(743DL) "Manufacturing Control" presents advantages of maker's methods for administering functions of production management.—International Business Machines Corp., 590 Madison Ave., New York 22, N. Y.

Circle **422** on inquiry card.

Pneumatic Controllers: New 6-page Bulletin DM-036 describes and illustrates features of maker's "Series 500 Free-Vane" pneumatic controllers for automatic control of temperature, flow, pressure, vacuum, etc.—Bristol Co., Waterbury 20, Conn.

Circle **423** on inquiry card.

Servomechanisms. New 4-page Bulletin TDS-1110, Rev. 1. 7-54 pictures and describes maker's "Servoboard Series 1110A", precision mechanical parts for building experimental mechanical assembly of servo system, computer or regulator; 4-page illustrated Bulletin TDS-1100, Rev. 1, 8-54 presents description and specifications of "Servoscope Series 1100" multiple signal generator.—Servo Corp. of America, New Hyde Park, N. Y.

Circle **424** on inquiry card.

Industrial Instrumentation. New 48-page issue of "Instrumentation" (Vol. 7, No. 4) contains articles on applications of instruments in processing gamma globulin, new sensitive weighing device, boiler tube measurement, new servo-analyzer, etc.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **425** on inquiry card.

Industrial Controls. New 30-page Bulletin CD-900 describes and illustrates maker's line of lever switches, Promatic control panels, electronic panels, limit switches, synchronous-motor timers.—General Control Co., 1200 Soldiers Field Rd., Boston 34, Mass.

Circle **426** on inquiry card.

Boiler Controls. New 4-page Bulletin 54-1088-239 presents specifications and schematic drawing for maker's fully automatic all electric metering type packaged control for shop assembled boiler.—Hays Corp., Michigan City, Ind.

Circle **427** on inquiry card.

Electronic Control. New 24-page illustrated Booklet F 6437 "The Electronic Control Story" covers fundamentals of electronic control and application, includes pickups, bridges, amplifiers, control actions.—Barber-Colman Co., Rockford, Ill.

Circle **428** on inquiry card.

Cycle Control. New 2-page illustrated brochure describes maker's "Robotron Type" cycle controls for plastic molding, rubber curing, chemical processing, etc.—Emmett Machine & Mfg., Inc., Akron 14, Ohio.

Circle **429** on inquiry card.

Servo Rate Generator. New 4-page Bulletin RGB1 gives construction, applications, design features, characteristics and specifications of maker's 60- and 400-cycle, linear, a-c. rate generators with high functional voltage output.—Ford Instrument Co., 31-10 Thomson Ave., Long Island City 1, N. Y.

Circle **430** on inquiry card.

Servo System. New 4-page Bulletin 54B pictures and describes maker's 60-cycle a-c. servomechanism system for remote transmission of motion.—Richardson Scale Co., Van Houten Ave., Clifton, N. J.

Circle **431** on inquiry card.

Sheet Separators. New 2-page Bulletin SS-210 pictures and describes maker's magnetic steel-sheet separators for handling round, square, nested, irregular or odd shaped stacks of steel sheets in production operations.—Homer Mfg. Co., Dept. 119, Lima, Ohio.

Circle **432** on inquiry card.

Cylinders. New 12-page brochure illustrates and describes maker's air and hydraulic cylinders for automation.—Miller Fluid Power Co., 2040 N. Hawthorne Ave., Melrose Park, Ill.

Circle **433** on inquiry card.

Industrial Controls. New 4-page issue of "Wheelco Comments" discusses industrial applications of maker's instruments for measurement and control.—Wheelco Instruments Div., Barber-Colman Co., Rockford, Ill.

Circle **434** on inquiry card.

MOTORS

Commutator Motors. New 22-page illustrated Catalog E1-2A covers electrical and physical characteristics and specifications for maker's commutator motors and governor motors.—Electric Indicator Co., Inc., Camp Ave., Springdale, Conn.

Circle **435** on inquiry card.

Synchronous Motors. New 4-page Catalog 403-2 covers specifications, diagrams, and special features of maker's hysteresis synchronous motors.—Technical Development Corp., 4060 Ince Blvd., Culver City, Calif.

Circle **436** on inquiry card.

Motors, Electrical Equipment. New 40-page Bulletin 245 presents diagrams and specifications of maker's rotary electrical equipment; 4-page Bulletin 154 pictures and describes "Dyna-Chek" dynamometers for measuring electric motors of 2 hp. and less; 2-page bulletin pictures and describes maker's high-precision gears.—Mission-Western Engineers, Inc., 132 W. Colorado St., Pasadena, Calif.

Circle **437** on inquiry card.

Motor-alternator. New 2-page illustrated bulletin presents applications, features, and performance of maker's "Model SA-40" 420-cps. synchronous motor-alternator.—Electric Motors and Specialties, Inc., King and Hamsher Sts., Garrett, Ind.

Circle **438** on inquiry card.

D-c., A-c. Generators. New 16-page Catalog E1-1A presents electrical characteristics, physical specifications and construction of maker's d-c. permanent-magnet tachometer generators, d-c. wound field generators, a-c. permanent-magnet generators and a-c. sine wave generators.—Electric Indicator Co., Inc., Springdale, Conn.

Circle **439** on inquiry card.

VALVES

Needle Valves. New 6-page bulletin describes and illustrates six new "Series 1206" bellows-seal needle valves for liquid or vapor.—Aveco Inc., Amsterdam, N. Y.

Circle **440** on inquiry card.

Solenoid Valves. Three new 2-page bulletins describe and illustrate maker's solenoid-operated valves and solenoids.—Carruthers & Fernandez, Inc., 1501 Colorado Ave., Santa Monica, Calif.

Circle **441** on inquiry card.

Servo Valve. New 4-page brochure pictures and describes maker's "FC-2" flow control servo valve.—Cadillac Gage Co., P. O. Box 3806, Detroit 5, Mich.

Circle **442** on inquiry card.

Hydraulic Valves. New 10-page Catalog 1551A presents dimensional data and features of maker's hydraulic directional control valves for mobile equipment applications. Covers 1, 2, 3, and 4-spool models from 8 to 35 gpm. capacity.—Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

Circle **443** on inquiry card.

TEMPERATURE

Pocket Pyrometer. New 8-page illustrated brochure describes maker's pocket-size shock-resistant "Series

240-T" indicating pyrometers, and "Cyber-tac Model 505" temperature controller.—Cybertronic Corp. of America, 3rd & Morton Ave., Chester, Pa.

Circle **444** on inquiry card.

Dial Thermometers. New 4-page illustrated brochure covers features and specifications of maker's dial thermometers.—Marshall Instruments Inc., 7333 Coldwater Canyon Ave., N. Hollywood, Calif.

Circle **445** on inquiry card.

Units of Measure. New 32-page booklet is tabular summary of U. S. Units of Measure with reciprocal conversion factors and graphic chart for temperatures.—New York Laboratory Supply Co., Inc., 76 Varick St., New York 13, N. Y.

Circle **446** on inquiry card.

Temperature, Frequency. New 12-page Catalog 354 describes and illustrates maker's vibrating-reed frequency meters, appliance temperature testers, toggle switches, temperature indicators, instrument and tester switches, etc.—J-B-T Instruments, Inc., New Haven 8, Conn.

Circle **447** on inquiry card.

FLOW

Steam, Gas Meter. New 4-page Catalog 5001 outlines construction, operating principle and applications of maker's "Critiflo-Meter" for measurement and control of steam and gases.—King Engineering Corp., Box 610, Ann Arbor, Mich.

Circle **448** on inquiry card.

Metering Pumps. New 4-page Bulletin 2 describes and illustrates maker's metering pumps which meter small quantities of fluids by means of motor-driven single-revolution clutch, pawl and rachet mechanism.—Edward E. Robinson Inc., P. O. Box 47, 95 Park Ave., Nutley 10, N. J.

Circle **449** on inquiry card.

Weigh-feeding. New 4-page bulletin and three 2-page bulletins describe and illustrate maker's weigh-feeding units for handling plastics, liquids, and dry materials.—Glengarry Equipment Corp., Bay Shore, N. Y.

Circle **450** on inquiry card.

Water Jet Eductors. New 36-page Bulletin 2-M presents information on design, construction, applications and operation of maker's water jet eductors.—Schutte and Koerting Co., Cornwells Heights, Bucks County, Pa.

Circle **451** on inquiry card.

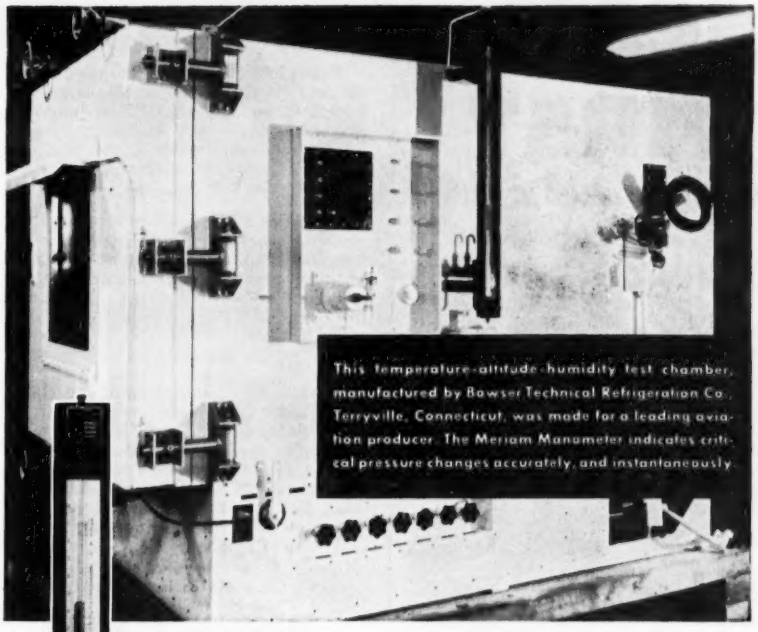
Closed Systems. New 4-page issue of "Autocon Rambler" (Vol. 6, No. 2) features article on closed systems for efficient distribution without storage tanks.—Automatic Control Co., 1005 University Ave., Saint Paul 4, Minn.

Circle **452** on inquiry card.

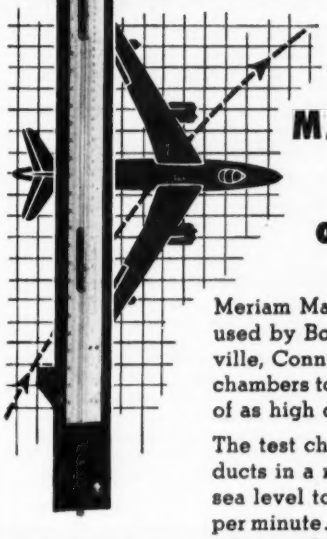
PRESSURE

Pressure Control. New 20-page illustrated Bulletin 4300 describes maker's "SR-4" load, torque and fluid pressure measurement and control devices and equipment.—Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.

Circle **453** on inquiry card.



This temperature-altitude-humidity test chamber, manufactured by Bowser Technical Refrigeration Co., Terryville, Connecticut, was made for a leading aviation producer. The Meriam Manometer indicates critical pressure changes accurately, and instantaneously.



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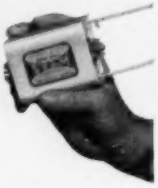

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MANUFACTURERS' NEW LITERATURE

Frangible Disks. New 30-page series of catalog sheets presents design, dimensions and diagrams of maker's frangible disks for pressure system protection.—Frangible Discs, Inc., 57 Railroad Ave., Penns Grove, N. J.

Circle **454** on inquiry card.

Pressure Pickup. New 2-page illustrated brochure lists features and specifications of maker's new pressure pickup capable of measurement at 6000-deg. F.—Photocon Research Products, 421 N. Foothill Blvd., Pasadena 8, Calif.

Circle **455** on inquiry card.

Pressure Controls. New Steam Catalog Folder F-127-544 contains series of bulletins that describe and illustrate maker's pressure regulators, relief valves, low-pressure low-water cut-off, automatic feed valve and strainer, etc., and 16-page paper on back siphonage from the engineering aspect. —Watts Regulator Co., Lawrence, Mass.

Circle **456** on inquiry card.

FREQUENCY, SPEED

Frequency, Speed. New 6-page issue of "Biddle Instrument News" (Vol. 10, No. 3) contains articles on frequency meters, speed measurement, insulation testers, tachometers, etc.—James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa.

Circle **457** on inquiry card.

Frequency Meter. New 2-page brochure presents description and applications of maker's new "Colortone" precision frequency meter.—Colortone Electronics, Inc., 238 William St., New York, N. Y.

Circle **458** on inquiry card.

Frequency Recorder. New 2-page Data Sheet 9.1-8a presents operation, construction and specifications of maker's frequency recorder for checking generator performance.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **459** on inquiry card.

Tachometers. New 4-page Bulletin 770-A lists features, specifications, and dimensions of maker's portable and stationary "Standco" vibrating-reed tachometers.—Herman H. Sticht Co., Inc., 27 Park Place, New York, N. Y.

Circle **460** on inquiry card.

Speed Reducers. New 8-page illustrated Bulletin CD-323 describes maker's line of shaft-mounted speed reducers.—Cone-Drive Gears, Div., Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

Circle **461** on inquiry card.

TIMING, COUNTING

Repeat Cycle Timers. New 2-page Bulletin RC200 describes cycling time, timing accuracy, detail characteristics and determination of timing tolerances of maker's new line of miniature hermetically-sealed repeat cycle timers. —A. W. Haydon Co., 230 North Elm St., Waterbury, Conn.

Circle **462** on inquiry card.

Mechanical Counter. New 2-page illustrated brochure presents applications, specifications, description and typical circuits for maker's "Digipot and Digicon Series 1100" mechanical counter with potentiometers or contacts on each wheel.—Wright Engineering Co., 180 E. California St., Pasadena 1, Calif.

Circle **463** on inquiry card.

Process Timers. New 4-page Bulletin 55-2 describes maker's process timers; 2-page illustrated Bulletin PC-1 presents maker's program signal controls for automatically sounding bells, sirens, etc.—Stromberg Time Corp., 135 South Main St., Thomaston, Conn.

Circle **464** on inquiry card.

Counter. Three new 2-page bulletins describe and illustrate maker's "PC-500 and CC-500 Series" control counter, "Model MC-505AS" add-and-subtract magnetic counter and "Model

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MC-504 SZL" magnetic counter with zero level control.—Photocon Research Products, 421 N. Foothill Blvd., Pasadena 8, Calif.

Circle **465** on inquiry card.

Timer-Flasher. New 2-page bulletin presents description and specifications of maker's "Magic Box" adjustable precision timer said to control up to 17 electrical loads with split-second accuracy.—Gale Dorthea Mechanisms, 81-01 Broadway, Elmhurst, L. I., N. Y.

Circle **466** on inquiry card.

Time Switches. New 44-page catalog illustrates and describes maker's line of time controls including on and off time switches, 7-day calendar dial switches, ventilating control, cycle repeaters, etc.—Paragon Electric Co., 1600 Twelfth St., Two Rivers, Wis.

Circle **467** on inquiry card.

COMPUTING

Analog Computers. New 24-page illustrated catalog presents specifications and example problems that can be solved on maker's "MC 400" compact, custom-built analog computer; 6-page brochure covers features and specifications of "MC-500" d-c. analog computer; 6-page bulletin describes and illustrates six-channel "MC-600" electronic function generator; 6-page illustrated bulletin lists features of new six-channel recorder for d-c. analog computers.—Mid-Century Instrumatic Corp., 611 Broadway, New York 12, N. Y.

Circle **468** on inquiry card.

Digital Computers. New 4-page issue of "Engineering News" (Vol. 7, No. 4) features article on digital computer for business men. Also discusses connectors, circuit analyzer, impedance bridge, and hypot tester.—American Phenolic Corp., 1830 South 54th Ave., Chicago 50, Ill.

Circle **469** on inquiry card.

Digital Converter. New 4-page Brochure 54-A-8 covers description, features, specifications, and electrical characteristics of maker's "Model D1-4-54" miniaturized low-torque direct-reading digital converter.—Dayton Instrument, Inc., 404 Winston Ave., Dayton, Ohio.

Circle **470** on inquiry card.

Resolver. New 2-page Bulletin 5244-15T covers construction, function, technical data, and specifications for "Size 15 Telesyn" resolver.—Ford Instrument Co., Div. of Sperry Corp., 31-10 Thomson Ave., Long Island City 1, N. Y.

Circle **471** on inquiry card.

RECORDING

Operation Recorders. New 4-page illustrated Bulletin OP-1505 describes and illustrates maker's electrical and mechanical operation recorders.—Bristol Co., Waterbury 20, Conn.

Circle **472** on inquiry card.

Recording Oscillograph. New 12-page illustrated Bulletin CEC-1521A lists features and specifications of maker's new "Type 5-116" recording oscillograph.—Consolidated Engineer-

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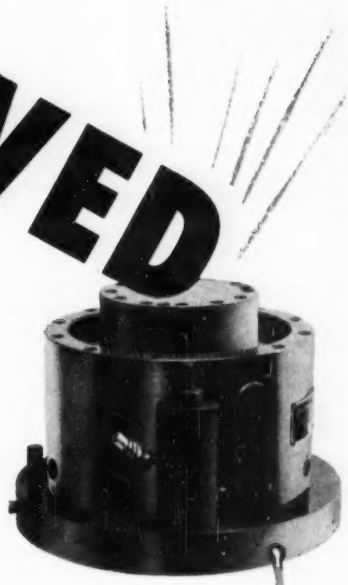

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ing Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

Circle **473** on inquiry card.

Oscillographs, Bridge Circuits. New 8-page issue of "The Right Angle" (Vol. 2, No. 1) features article on bridge circuits; also direct writing oscillograph, reluctance type pickups, etc.—Sanborn Co., Cambridge 39, Mass.

Circle **474** on inquiry card.

Recording Potentiometer. New 4-page Data Sheet 9.1-9a describes telemetering system incorporating maker's recording potentiometer.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **475** on inquiry card.

Oscillography. New 4-page Bulletin 105-5-54 describes and illustrates maker's electronic instruments for precision test measurement including oscillographs, amplifiers, transducers, calibrators, etc.—Wm. Miller Instruments, Inc., 325 N. Halstead Ave., Pasadena 8, Calif.

Circle **476** on inquiry card.

Recording Oscillograph. New 4-page illustrated brochure lists features and specifications of maker's new "CR-I" cathode-ray recording oscillograph.—Wm. Miller Instruments, Inc., 325 N. Halstead Ave., Pasadena 8, Calif.

Circle **477** on inquiry card.

Recording System. New 2-page illustrated brochure describes maker's "150" oscillographic recording systems.—Sanborn Co., Industrial Div., Cambridge 39, Mass.

Circle **478** on inquiry card.

Photo Trace Recorder. New 24-page illustrated Working Instructions EG 18-1e and 2-page Bulletin 809e present operation and applications of German-made "Lumiscript RLt4" high-speed photo trace recorder.—Electronic Engineering Associates, 1040 Brittan Ave., San Carlos, Calif.

Circle **479** on inquiry card.

Recorder, Oscillograph. New 2-page bulletin pictures and describes maker's new "Model F6C" console direct-writing recorder and six-channel oscillograph.—Photron Instrument Co., 6516 Detroit Ave., Cleveland 2, Ohio.

Circle **480** on inquiry card.

Oscilloscope Cameras. New set of bulletins describe and picture maker's "Recordoscope" automatic and manual oscilloscope cameras.—Aremac Associates, 329 W. Washington St., Pasadena, Calif.

Circle **481** on inquiry card.

LABORATORY, ANALYTICAL

Wet Film Applicator. New 4-page Bulletin 155 presents advantages, uses, description, diagrams and operation of maker's Ultra applicator, a new precision instrument for laying down wet test films of plastic coatings, paint, etc., of any desired thickness.—Gardner Laboratory, Inc., Bethesda 14, Md.

Circle **482** on inquiry card.

Viscometers. New 8-page Bulletin V-100E presents description, operation and design of maker's viscometers for recording or recording-controlling of viscosity in industrial plants.—Norcross Corp., Newton 58, Mass.

Circle **483** on inquiry card.

X-ray Quantometry. New 4-page issue of "Spectrographer's Newsletter" (Vol. 7, No. 2) features article on recent advances in x-ray quantometry.—Applied Research Laboratories, P.O. Box 1710, Glendale 5, Calif.

Circle **484** on inquiry card.

Infrared Components. New 2-page brochure pictures and describes all component parts for infrared telescope.—Edmund Scientific Corp., Barrington 3, N. J.

Circle **485** on inquiry card.

Standard Spectra. New 34-page catalog lists 5800 standard spectra compounds. Includes name according to Chemical Abstract System, emperical formula, molecular weight, structural formula, melting or boiling point, etc.—Sadtler Research Labs., 1517 Vine St., Phila. 2, Pa.

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Tube Furnaces. New 4-page Bulletin 310 presents description, dimen-

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sions, specifications, and heating elements for "H" and "BT Models" of maker's high-temperature electric tube furnaces.—Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.

Circle **487** on inquiry card.

Shaking Incubator. New 2-page illustrated Data Sheet 11482 presents capacity, temperature range, accuracy, shaking speed, and power requirements for maker's metabolic shaking incubator.—Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.

Circle **488** on inquiry card.

Color Control. New 8-page illustrated Bulletin FS-246 explains theory and use of new additive-colorimeter, a permanent color memory for control chemists in paint, food, textile, etc.—Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.

Circle **489** on inquiry card.

Laboratory Glassware. New 120-page Catalog CA-1 describes and illustrates maker's flasks, test tubes, bottles, burettes, cylinders, distilling apparatus, funnels, etc.—Corning Glass Works, Corning, N. Y.

Circle **490** on inquiry card.

Interference Microscopes. New 8-page Bulletin 818 illustrates and describes maker's "Models A and B" interference microscopes for surface measurements.—Farrand Optical Co., Inc., Bronx Blvd. & E. 238 St., New York 70, N. Y.

Circle **491** on inquiry card.

Laboratory Reagents. New 196-page Catalog C-6 lists over 6000 items including stains, indicators, sugars, diagnostic reagents, culture media and histological agents.—Will Corp., Rochester 3, N. Y.

Circle **492** on inquiry card.

OPTICAL

Industrial TV. New 4-page illustrated Bulletin 1175 presents, advantages, technical specifications, and applications of maker's "UtiliVue Series 400" closed-circuit television camera.—Diamond Power Specialty Corp., Lancaster, Ohio.

Circle **493** on inquiry card.

Photoelectric Instruments. New 4-page Bulletin 100 describes and illustrates maker's line of photoelectric and electronic measuring instruments.—Photovolt Corp., 95 Madison Ave., New York 16, N. Y.

Circle **494** on inquiry card.

Ellipsometer. New 4-page Bulletin EL-1 presents theory and description of "Model 430" visual and photoelectric ellipsometer.—O. C. Rudolph & Sons, P. O. Box 446, Caldwell, N. J.

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Photoelectric Relays. New 6-page brochure presents description, diagrams, photographs, and specifications of maker's pulsed-beam photoelectric relays for industry.—Electronic Control Corp., 1573 E. Forest Ave., Detroit 7, Mich.

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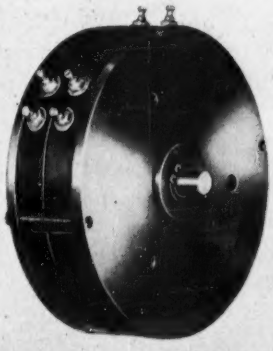

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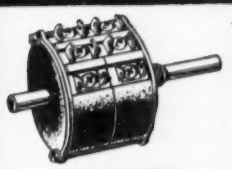

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MANUFACTURERS' NEW LITERATURE

Sky Compass. New 4-page Bulletin M-69-1500 presents description and diagrams of maker's sky compass for accurate reading of true heading of aircraft, under conditions which preclude use of standard navigational instruments.—Kollsman Instruments Corp., 80-08 45th Ave., Elmhurst, L. I., N. Y.

Circle **497** on inquiry card.

Lens Polishing. New 4-page brochure illustrates and describes maker's four-spindle "Polishmaster" optical polishing machine.—R. Howard Strasbaugh, 10990 Santa Fe Ave., Lynwood, Calif.

Circle **498** on inquiry card.

RADIOACTIVITY

Radiation Materials. Three new 4-page issues of "Radiations" discuss new developments in radiation materials including isolite calibration standards, radioisotope sources, etc.—United States Radium Corp., 535 Pearl St., New York 7, N. Y.

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Geiger Scaler. New 2-page brochure presents description and specifications of "Model A-65" geiger scaling unit for educational, research, or hospital radioisotopes programs.—Atomic Center, 489 Fifth Ave., New York 17, N. Y.

Circle **500** on inquiry card.

Remote Handling. New 2-page bulletin lists features of maker's new master-slave manipulator "Model 8" for remote handling.—Central Research Laboratories, Inc., Dept. 201, Red Wing, Minn.

Circle **501** on inquiry card.

X-ray Generator. New 6-page Bulletin JR describes and pictures maker's new Van de Graaff "Model JR" 1,000,000-volt x-ray generator.—High Voltage Engineering Corp., 7 University Rd., Cambridge 38, Mass.

Circle **502** on inquiry card.

Counter Tubes. New 24-page illustrated Catalog 51T covers descriptions and technical information for maker's line of counter tubes and accessories.—Anton Electronic Laboratories, Inc., 1226 Flushing Ave., Brooklyn 37, N. Y.

Circle **503** on inquiry card.

Dosimeters. New 2-page Bulletin D-3 describes direct-reading dosimeters with built-in charger, using one size D cell; 2-page Bulletin R-4 describes improved "Model L-61 RK" roentgen dose meters.—Landsverk Electrometer Co., 550 West Garfield Ave., Glendale 4, Calif.

Circle **504** on inquiry card.

GAGING

Air Gages. New 30-page Catalog PCI-53-4 describes and illustrates maker's "Precisionaire" air gages, tooling, and accessories.—Sheffield Corp., Dayton 1, Ohio.

Circle **505** on inquiry card.

Thread Comparator. New 4-page Circular 570 describes and illustrates maker's precision "Tri-Roll" thread comparator for gaging external threads.—Pratt & Whitney, West Hartford 1, Conn.

Circle **506** on inquiry card.

Bore Gages. New 2-page bulletin illustrates and describes maker's "844" self-centering bore gages.—Geo. Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y.

Circle **507** on inquiry card.

TORQUE

Torque Limiter. New 8-page Catalog C 14-54 illustrates, describes, and lists applications for maker's torque limiter for drives and couplings.—Morse Chain Co., 7601 Central Ave., Detroit 10, Mich.

Circle **508** on inquiry card.

Torque Tools. New 16-page catalog covers maker's line of torque testing equipment and torque tools; 2-page illustrated brochure describes new "Roto-torq Model PM-5" torque screwdriver.—Richmont, Inc., 922 So. Myrtle Ave., Monrovia, Calif.

Circle **509** on inquiry card.

TESTING

Test Stands, Panels. New 6-page illustrated Bulletin 541 describes maker's "Viz-O-Line" test stands, test stand cabinets, and instrument panels.—Industrial Engineering Corp., 2720 Vine St., Cincinnati, Ohio.

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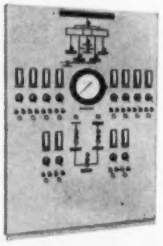

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Concrete Testers. New 4-page Bulletin 504 describes and pictures maker's four precision concrete testers.—Forney's Inc., P. O. Box 310, New Castle, Pa.

Circle **511** on inquiry card.

Hardness Tester. New 2-page illustrated Brochure F 1689-2 presents data on maker's portable hardness tester for aluminum, aluminum alloys, copper, brass, and other materials including plastic.—Barber-Colman Co., 1200 Rock St., Rockford, Ill.

Circle **512** on inquiry card.

Cohesion Tester. New 4-page brochure pictures, describes, and gives operating instructions for maker's cohesion tester for rayon and raw silk. —Geier & Bluhm, Inc., Troy, N. Y.

Circle **513** on inquiry card.

Smoothness Tester. New 4-page illustrated brochure describes maker's smoothness and porosity tester for accurate determination of smoothness of paper.—R. Fuess, Inc., 39 West 60 St., New York 23, N. Y.

Circle **514** on inquiry card.

VIBRATION

Vibration Meter. New 4-page Bulletin CEC-1505C illustrates and describes maker's "Type 1-110B" vibration meter and accessories for velocity and displacement measurement.—Consolidated Engineering Corp., 300 North Sierra Madre Villa, Pasadena 15, Calif.

Circle **515** on inquiry card.

Vibration Control. New 8-page Catalog 701 explains how maker's vibration damping units can be designed and manufactured for specific applications.—General Tire and Rubber Co., Industrial Products Div., Wabash, Ind.

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MOISTURE

Moisture Measurement. New 4-page illustrated brochure lists features and advantages of maker's new "Hygrotester-Boy", first portable dielectric moisture measuring instrument for makers and converters of pulp, paper, board, cellophane, etc., and "Supertest 712" for moisture measurement on large fast machines.—Hygrotester Inc., 101 Henry St., P. O. Box 923, Brooklyn 1, N. Y.

Circle **517** on inquiry card.

Vapor Removal. New 4-page Bulletin SC-1047 presents features and operation of maker's "Vape-Sorber" for continuous removal of petroleum vapor, dirt, and liquids from compressed air and other gases.—Selas Corp. of America, Fluid Processing Div., Phila. 34, Pa.

Circle **518** on inquiry card.

POWER SUPPLIES

Power Supplies. New 4-page illustrated brochure describes maker's power supplies for transistor circuits. —Burgess Battery Co., Freeport, Ill.

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Batteries. New 6-page illustrated Brochure DM-994 includes features, advantages, technical data, and specifications of maker's silver-zinc

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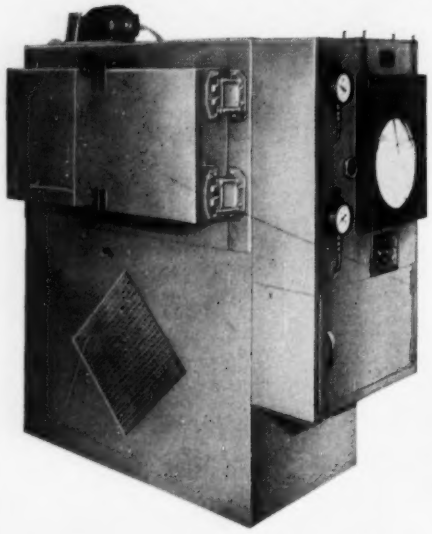

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NEW LITERATURE

batteries.—AMF Contract Div., American Machine & Foundry Co., 261 Madison Ave., New York 16, N. Y.
Circle **520** on inquiry card.

Power Supply. New 2-page issue of "Keithley Engineering Notes" presents specifications of maker's new "Model 2004A" regulated voltage supply with 0-1 milliamp. output and 0.01 percent line regulation.—Keithley Instruments, 3868 Carnegie Ave., Cleveland, Ohio.
Circle **521** on inquiry card.

Meters, Power Supplies. New 2-page illustrated bulletin describes maker's "VAW" meters for measuring volts, amps, and watts; and d-c. power supplies.—John Fluke Mfg. Co., Inc., 1111 W. Nickerson St., Seattle 99, Wash.
Circle **522** on inquiry card.

ELECTRONIC INSTRUMENTS

Transistor Oscillator. New 8-page issue of "General Radio Experimenter" (Vol. 29, No. 3) features article on pocket-size transistor oscillator for audio-frequency testing.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Circle **523** on inquiry card.

Indicating Amplifier. New 2-page Bulletin 1A presents engineering data and performance curves for maker's "Type 2HLA-3" d-c. indicating amplifier for measurement and amplification.—Doelcam Corp., Soldiers Field Rd., Boston 35, Mass.
Circle **524** on inquiry card.

Oscillator. New 2-page bulletin pictures and describes maker's new "DK-1" oscillator, a source of sine wave power for general lab use and production testing.—Neucor Inc., 45 W. Union St., Pasadena 1, Calif.
Circle **525** on inquiry card.

Pulse Instruments. New 4-page General Catalog 1-54 presents function, range, and descriptions of maker's block unitized pulse instruments; 2-page Bulletin 2120-A pictures and describes "Model 2120A" pulse generator; 4-page 2140A presents applications, operation, and characteristics of "Model 2140A" pulse generator.—Electro-Pulse, Inc., 11811 Major St., Culver City, Calif.
Circle **526** on inquiry card.

Oscilloscopes. New 4-page brochure illustrates and describes maker's "Type 530" series oscilloscopes with plug-in preamplifiers.—Tektronix Inc., P. O. Box 831, Portland 7, Ore.
Circle **527** on inquiry card.

Magnetic Amplifiers. New 4-page Bulletin F-642 presents description and illustrates applications of maker's magnetic amplifier systems.—Federal Telephone and Radio Co., 100 Kingsland Rd., Clifton, N. J.
Circle **528** on inquiry card.

30-Mc. IF Amplifier. New 8-page issue of "General Radio Experimenter" (Vol. 28, No. 12) features article on maker's new "Type 1216-A"

amplifier.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Circle **529** on inquiry card.

Electronic Instruments. New 2-page bulletin pictures and describes maker's power supplies, meter calibrators, television intercoms, decade amplifiers, etc.—Kay Lab, 1090 Morena Blvd., San Diego 10, Calif.

Circle **530** on inquiry card.

Vector Impedance Bridge. New 4-page illustrated brochure presents features and specifications of maker's vector impedance bridge "Model 100-B" for use in lab, field, quality control, production testing.—Republic Engineering Co., Inc., Beltsville, Md.

Circle **531** on inquiry card.

Electrical Indicators. New 4-page brochure describes maker's line of standard range electrical indicating instruments available in round, square and rectangular models.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle **532** on inquiry card.

Phase Sequence Indicators. New 2-page bulletin pictures and describes maker's "PSI" units, which combine functions of pilot light and phase sequence indicator, for portable three-phase equipment.—Brunswick Instruments, P. O. Box 813, New Brunswick, N. J.

Circle **533** on inquiry card.

Radio Interference. New 6-page catalog covers description, design specifications, operating ranges, recommended applications and lists of accessories for maker's noise meters, distortion analyzers, impulse generators, attenuators and crystal mixers.—Empire Devices Products Corp., 38-15 Bell Blvd., Bayside 61, N. Y.

Circle **534** on inquiry card.

UHF Test Equipment. New 10-page illustrated catalog presents features and specifications of maker's oscilloprobe, square-wave generator, amplifier, uhf transformer, wavemeter, and other laboratory test equipment.—Linear Equipment Laboratories, Brightwater Place, Massapequa, L. I., N. Y.

Circle **535** on inquiry card.

Voltmeter. New 2-page Bulletin VM-100 pictures and describes maker's panel-mounting vacuum-tube voltmeter.—Trio Laboratories, P. O. Box 143, Wantagh, New York.

Circle **536** on inquiry card.

A-c. Voltmeter. New 2-page Bulletin 116 and 4-page Bulletin 101 present description, specification, and applications of maker's expanded scale a-c. voltmeter.—Arga Div., Beckman Instruments, Inc., So. Pasadena 1, Calif.

Circle **537** on inquiry card.

Business Telephone System. New 8-page Bulletin 1762 discusses in detail specific applications of maker's business telephone system in process control, product distribution, and general plant efficiency.—Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago 7, Ill.

Circle **538** on inquiry card.

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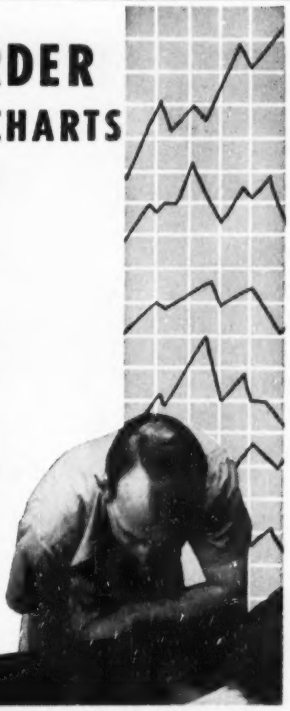

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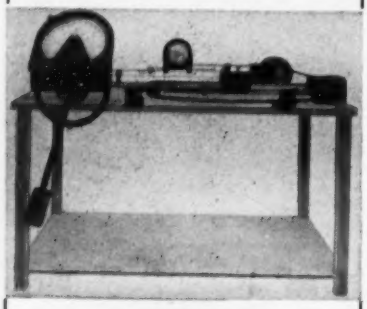

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MANUFACTURERS' NEW LITERATURE

Cable Fault Locater. New 2-page Bulletin 65-P5 illustrates and describes maker's impulse cable-fault locating transmitter; 2-page Bulletin 65 P-3 describes "Model 4" transmitter, high-voltage bridge, and accessory pickup loop.—James G. Biddle Co., 1316 Arch St., Phila. 7, Pa.

Circle **539** on inquiry card.

Acoustical Research. Five catalog sheets present descriptions, diagrams, and photographs of Danish-made instruments for acoustical research including reverberation time recorders, F. I. computers, etc.; 12-page issue of "Technical Review" (No. 3, July 1954) features article on mobile laboratories.—Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio.

Circle **540** on inquiry card.

Electronic Equipment. New 308-page Catalog describes and illustrates over 25,000 items including industrial maintenance equipment, radio and electronic parts and equipment, remote control television camera, recording equipment, etc.—Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.

Circle **541** on inquiry card.

SWITCHES, RELAYS

Rotary Switches. New 4-page illustrated folder covers features, electrical data and dimensional details of new subminiature rotary switches for low current applications.—Electro Development Co., 6006 W. Washington Blvd., Culver City, Calif.

Circle **542** on inquiry card.

Switch Assemblies. New 2-page Data Sheet P91 presents description and diagrams of maker's "13AT Series" subminiature toggle switch assemblies.—Micro Switch, Freeport, Ill.

Circle **543** on inquiry card.

D-c. Solenoids. New illustrated 4-page Bulletin SO-100-300 presents description, diagrams and specifications of maker's "Series 100 and 300" d-c. solenoids.—Joseph Pollak Corp., 81 Freeport St., Boston 22, Mass.

Circle **544** on inquiry card.

Meter Test Switch. New 8-page illustrated Bulletin 48 describes maker's new meter test switch.—Eastern Specialty Co., Philadelphia 40, Pa.

Circle **545** on inquiry card.

Switches, Relays. New 4-page illustrated brochure describes maker's coils, relays, transformers, switches, hermetic sealing, and solenoids.—Comar Electric Co., 3349 Addison St., Chicago 18, Ill.

Circle **546** on inquiry card.

Relays. New 6-page illustrated brochure and 4-page insert describe maker's relays for every application.—Advance Electric and Relay Co., 2435 N. Maomi St., Burbank, Calif.

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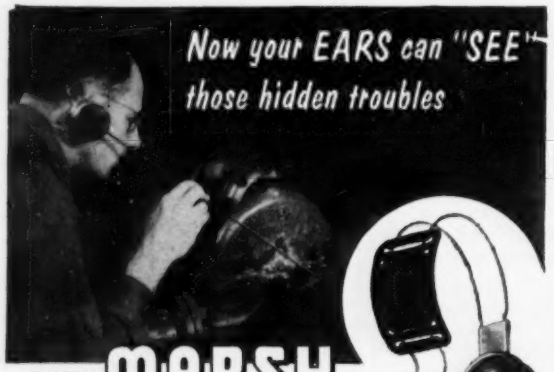

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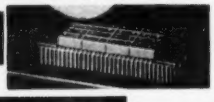

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Time Delay Relays. New 2-page illustrated Bulletin TD400 lists design features of maker's "6400, 11400, 24300 Series" miniature hermetically-sealed time delay relays.—A. W. Haydon Co., Waterbury 20, Conn.

Circle **548** on inquiry card.

RESISTORS, POTENTIOMETERS

Resistance Decade Box. New 2-page illustrated brochure lists features and specifications of maker's "Dekabox" compact precision decade box. Electro-Measurements, Inc., 4312 S. E. Stark St., Portland 15, Oregon.

Circle **549** on inquiry card.

Resistors. New 2-page issue of "Ohmite News" (July 1954) pictures and describes maker's wire-wound resistors, "Type AB" potentiometers, resistance box, etc.—Ohmite Mfg. Co., 3603 Howard St., Skokie, Ill.

Circle **550** on inquiry card.

Boro-carbon Resistors. New 2-page Bulletin L-33 presents specifications and electrical performance data for maker's "Borohm" deposited boro-carbon resistors.—Shallcross Mfg. Co., Collingdale, Pa.

Circle **551** on inquiry card.

Potentiometers. Two (Form A-6 "Dekaviders;" "Dekapots") 2-page illustrated brochures list features, specifications and applications of maker's precision voltage dividers and potentiometers.—Electro-Measurements, Inc., 4312 S. E. Stark St., Portland 15, Ore.

Circle **552** on inquiry card.

Miniature Potentiometers. Two new 2-page Bulletins 4591C and 4581 cover standard resistance values, features, specifications, and dimensions of maker's carbon and wire-wound "Trimpot Model 120" 25-turn adjustable subminiature potentiometers.—Bourns Laboratories, 6135 Magnolia Ave., Riverside, Calif.

Circle **553** on inquiry card.

Potentiometers, Delay Lines. New 8-page issue of "Helinews" (No. 6, July 1954) features articles on maker's potentiometers and delay lines.—Helipot Corp., South Pasadena, Calif.

Circle **554** on inquiry card.

Potentiometers. Three new 2-page brochures present descriptions and specifications for maker's "Model 200, 300, and 400 Series" precision single-turn potentiometers.—Spectrol Corp., 1704 S. Del Mar, San Gabriel, Calif.

Circle **555** on inquiry card.

Potentiometer. New 4-page bulletin lists design features, applications, specifications, and resistances of low-torque microfriction potentiometer.—American British Electric Corp., 57 Park Ave., New York 16, N. Y.

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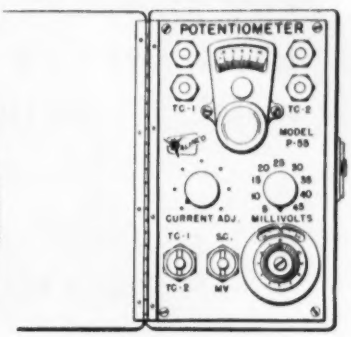
ELECTRONIC COMPONENTS

Plug-in Components. New 4-page catalog illustrates and describes line of plug-in components including connectors, anode cables, plugs, terminal

A miniaturized POTENTIOMETER



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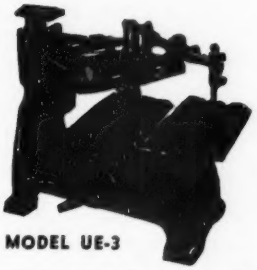

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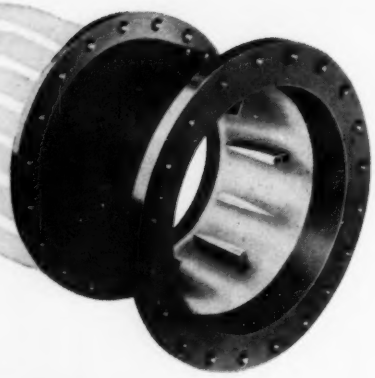

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NEW LITERATURE

cards, etc.—Alden Products Co., 117 North Main St., Brockton 64, Mass.

Circle **557** on inquiry card.

Aircraft Components. New 2-page Form HC 5307 describes and pictures maker's vertical gyros, relays, special motors, fire and heat detectors, and miniature slip-rings and brushes.—Iron Fireman Electronics Div., 2838 S. E. Ave., Portland, Ore.

Circle **558** on inquiry card.

Bridge Rectifier. New 4-page issue of "International Rectifier News" (RN-654) features article on advantages and application of bridge rectifier.—International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.

Circle **559** on inquiry card.

Germanium Diodes. New 8-page illustrated Bulletin SP2A presents features, construction, characteristics, and applications of maker's germanium diodes fusion-sealed in glass.—Hughes Aircraft Co., Culver City, Calif.

Circle **560** on inquiry card.

Semiconductors. Four new data sheets describe maker's "Types 600C and 601C" silicon junction diodes, small signal silicon grown-junction transistors, "X-15" medium power silicon transistor, and other semiconductor devices.—Texas Instruments, 6000 Lemmon Ave., Dallas 9, Texas.

Circle **561** on inquiry card.

Miniature Connectors. New 4-page Bulletin PR-DP1 presents description and diagrams of maker's "DPA and DPX" miniature connectors.—Cannon Electric Co., 3209 Humboldt St., Los Angeles 31, Calif.

Circle **562** on inquiry card.

Hermetic Terminals. New 4-page Bulletin 5410 describes and illustrates maker's metalized hermetic terminals which meet L5A requirements of JAN-1-10 specifications.—American Lava Corp., Chattanooga 5, Tenn.

Circle **563** on inquiry card.

Transformers. New 6-page Bulletin HD499 pictures and describes maker's dry-type transformers for power and lighting circuits, electric furnace control, phase changing, indoor sub-stations, machine control circuits, motor starters, etc.—Hevi-Duty Electric Co., Milwaukee 1, Wis.

Circle **564** on inquiry card.

Miniature Wire, Cable. New 18-page brochure illustrates and describes maker's line of miniature and sub-miniature wire and cable.—Tensolite Insulated Wire Co., Inc., Tarrytown, N. Y.

Circle **565** on inquiry card.

Connectors. New 2-page illustrated data sheet gives specifications, schematic drawings, electrical and mechanical ratings, and molding compounds for maker's new "Series 800" high-voltage precision 15-contact connectors for AN-36 shell.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle **566** on inquiry card.

Brushes, Contacts. New 66-page catalog describes maker's "Graphalloy" metal-impregnated graphite bushings, brushes, contacts, and seal rings.—Graphite Metallizing Corp., 1050 Nepperham Ave., Yonkers 3, N. Y.

Circle **567** on inquiry card.

Miniature Connectors. New 2-page bulletin gives characteristics, drawings, and specifications on "Series G-20" miniature connector and "Series HC-20" hexagonal hermetic plug.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle **568** on inquiry card.

Hermetic Sealing. New 4-page illustrated brochure explains "why and how" of hermetic sealing for electrical and electronic components and assemblies.—General Hermetic Sealing Corp., 99 E. Hawthorne Ave., Valley Stream, L. I., N. Y.

Circle **569** on inquiry card.

Lighting Plates. New 2-page brochure presents description and diagrams of maker's "Special Coating" Transilluminated plastic lighting plates.—Bodnar Industries, Inc., 15-19 Railroad Ave., New Rochelle, N. Y.

Circle **570** on inquiry card.

Waveguide Disconnect. New 2-page brochure pictures and describes maker's waveguide "Quick Disconnect."—Aircraft Armaments Inc., P. O. Box 1777, Baltimore 3, Md.

Circle **571** on inquiry card.

Pressurized Plugs. New 2-page bulletin illustrates and describes "Series PE-Z 16" pressurized plugs and aluminum hoods for "E-Z" release connectors.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle **572** on inquiry card.

Transformers, Delay Lines. New set of bulletins presents specifications, features, characteristics and illustrations of maker's miniature distributed-parameter delay lines, miniature continuously-variable delay lines, miniature pulse transformers.—Gudeman Co. of Calif., Inc., 9200 Exposition Blvd., Los Angeles 34, Calif.

Circle **573** on inquiry card.

Powder Cores. New 4-page Bulletin PC-103 describes standard sizes, electrical specifications, tolerances, and finishes of maker's molybdenum permalloy powder cores.—Magnetics, Inc., Butler, Pa.

Circle **574** on inquiry card.

Wires, Cables. New 6-page illustrated brochure describes maker's "Plasticord-Plasticote" wires and cables for radio, electronics and television industries.—Chester Cable Corp., Chester, N. Y.

Circle **575** on inquiry card.

Variable Inductances. New 4-page reprint from "Radio and Television News" describes shop and laboratory use of permeability tuned inductances covering range 1 to 1000 microhenries; 4-page brochure pictures and describes line of television accessories.—United Technical Laboratories., Morristown, N. J.

Circle **576** on inquiry card.

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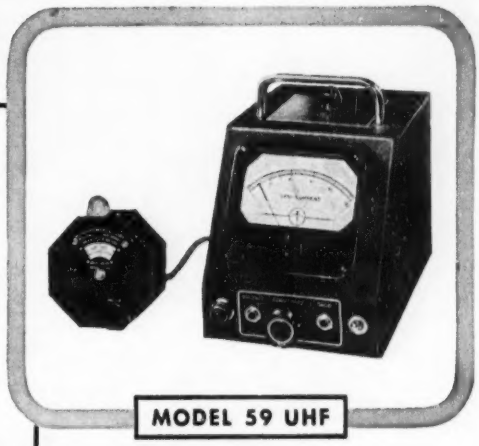

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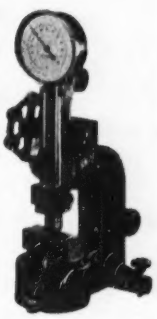

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MANUFACTURERS' NEW LITERATURE

Transducers, Oscillator. Three new 2-page bulletins present description, applications, and specifications of maker's "Series P300" pressure-to-frequency transducer, "Series 0200" inductance-controlled telemetering oscillator, and "Series P100" pressure transducer.—Datran Engineering Corp., 6312 W. 92nd St., Los Angeles 45, Calif.

Circle **577** on inquiry card.

TOOLS, PARTS

Precision Cams. New 4-page illustrated Bulletin CB-754 covers construction, applications, and data on tolerances and materials, of maker's precision cams.—Ford Instrument Co., Div. of Sperry Corp., 31-10 Thomson Ave., Long Island City 1, N. Y.

Circle **578** on inquiry card.

Tool-making Accessory. New 8-page booklet presents description, operation and specifications of maker's polygon tool box, for capstan, turret and automatic lathes, which turns hexagonal, octagonal, square and other irregular shapes free from fraze and burrs.—Bradley Machinery Co., 211 Jos. Campau, Detroit 7, Mich.

Circle **579** on inquiry card.

Live Bushings. New 8-page catalog presents application photographs, engineering data, and performance features of maker's live pilot bearing bushings.—J. G. Jergens Div., Donley Products, Inc., 11106 Avon Ave., Cleveland 5, Ohio.

Circle **580** on inquiry card.

Beryllium Copper Springs. New 16-page Catalog 8 describes and illustrates maker's "Micro-Processed" beryllium springs. Includes brush, flat, and strip springs.—Instrument Specialties Co., Inc., Little Falls, N. J.

Circle **581** on inquiry card.

Metal Housings. New 26-page Catalog 48 describes and illustrates maker's line of metal cabinets, chassis, panels, racks, etc. for electronic apparatus.—Par-Metal Products Corp., 32-62 49 St., Long Island City 3, N. Y.

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Cabinet Lathe. New 12-page Catalog 918-SLB illustrates and describes maker's "918 Steelway" precision cabinet lathe and accessories and attachments.—Rivett Lathe & Grinder, Inc., Brighton 35, Boston, Mass.

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Clamps. New 60-page Engineering Manual 201G presents diagrams and specifications of maker's clamps including loop type, multiple cushioned, multiple wire or tube, etc.—Thomas Associates, 4607 Alger St., Los Angeles 39, Calif.

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Flexible Shafting. New 16-page illustrated Bulletin 528 is design manual of maker's flexible shafting for remote control of valves.—Stow Manufacturing Co., Binghamton, N. Y.

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Carbide Scriber. New 2-page Bulletin 565 illustrates and describes scriber for marking steel surfaces, ceramics, metals, glass, etc.—Spring Specialty Co., 23 North 5 Ave., Maywood, Ill.

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Industrial Slides. Two new slide selector charts present description and dimensional data for over 200 sliding mechanisms with 25 to 500 lbs. load capacity.—Grant Pulley & Hardware Corp., 31-85 Whitestone Pkwy., Flush-54, N. Y.

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MATERIALS

Industrial Glass. New 16-page Catalog 53A presents dimensions, weights, wall thicknesses and prices for maker's glass tubing and rod, capillary and low pressure gage tubes, oil cup cylinders, and glass wool fiber.—Friedrich and Dimmock, Inc., Millville, N. J.

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Molded Plastics. New 8-page illustrated Booklet F-242 describes thermoplastic and thermosetting facilities for producing short-run molded plastics.—Dayton Rogers Mfg. Co., Minneapolis 7, Minn.

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Diamond Abrasive. New 8-page brochure describes and illustrates methods and applications of maker's "Dymo" diamond abrasive.—Elgin National Watch Co., Elgin, Ill.

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Electrical Ceramics. New 4-page brochure presents electrical and mechanical properties of standard grades of maker's electrical ceramics with recommended applications.—General Ceramics Corp., Keasbey, N. J.

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Plastics, Insulation. New 6-page brochure presents description and applications of maker's "Plaskon" plastics and resins.—Barrett Div., Allied Chemical & Dye Corp., 40 Rector St., New York 6, N. Y.

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Potting Compound. New 6-page bulletin covers technical data and description of maker's potting compound "P-420"; 10-page bulletin describes bonding agent "R-13"; 6-page brochure presents application, technical data, and description of "Flawmaster" for eliminating sand pits, gas holes, cracks, etc., in precision metal parts.—Carl H. Biggs Co., Inc., 2255 Barry Ave., Los Angeles 64, Calif.

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Rubber, Plastics. New 16-page illustrated bulletin, Form 42, covers maker's molded and extruded rubber and plastics; rubber-to-metal bonded parts; vibration control units, and plastics-reinforced fiber glass parts.—General Tire & Rubber Co., Industrial Products Div., Wabash, Ind.

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Plastic Laminations. New 2-page bulletin describes laminating process for thermoplastic and thermosetting laminations under JAN-P-15 and MIL-P-78A specifications.—Wilson Camera Co., Inc., 1401 Lawrence Rd., Havertown, Pa.

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Insulators. New 4-page illustrated Bulletin 549 discusses new process for making ceramic internal insulators for electron tubes in strong, thin intricate shapes.—American Lava Corp., Chattanooga 5, Tenn.

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Phosphate Bonded Talc. New 8-page reprint from "Journal of the American Ceramic Society" presents full information on new phosphate bonded talc, a block talc substitute.—American Lava Corp., Chattanooga 5, Tenn.

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Brazing Table. New 2-page table is guide to determining right amount of silver brazing alloying to use in standard pipe and tubing joints.—Handy & Harman, 80-84 Fulton St., New York 7, N. Y.

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MISCELLANEOUS

National Defense Technical Problems. New 24-page bulletin is 1954 list of technical problems facing national defense. List is issued in hope that ". . . wide dissemination of problems will lead to submission of satisfactory solutions . . ."—National Inventors Council, U.S. Department of Commerce, Washington 25, D. C.

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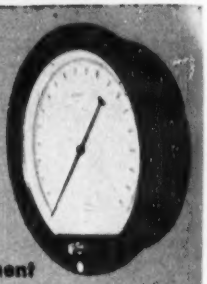

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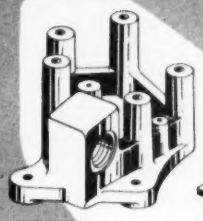

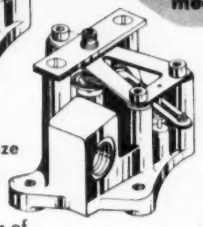

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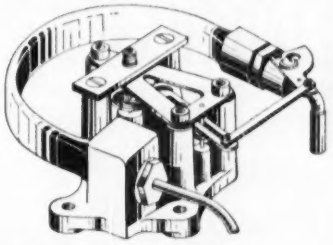

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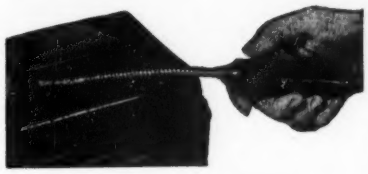

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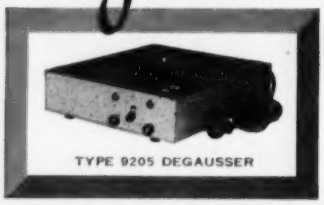

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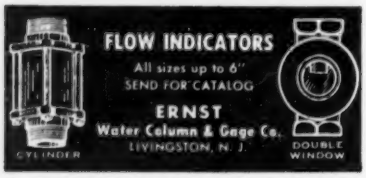

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Service Awards. New 16-page booklet "Industry's Medals of Honor" describes methods of setting up service award program, choosing design, and presentation methods.—American Emblem Co., Inc., Ogden Blvd., Utica 1, N. Y.

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Handling Equipment. New 4-page Folder 73 shows maker's line of "700" platform, bin, table, shelf and box trucks.—Wilder Mfg. Co., Inc., Mechanic St. & Erie R. R., Port Jarvis, N. Y.

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Electric Typing. New 4-page illustrated reprint from "Purchasing" describes advantages of electric typewriters.—International Business Machines Corp., Dept. of Information, 590 Madison Ave., New York 22, N. Y.

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Respirator. New 2-page Bulletin 1007-5 pictures and describes maker's new all-vision chemical cartridge respirator.—Mine Safety Appliances Co., 201 North Braddock Ave., Pittsburgh 8, Pa.

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Storage Cabinets. New 2-page Bulletin SB-4-53 illustrates applications and describes new "Swing-Bins" small parts storage cabinets with plastic drawers.—Akro-Mils, Inc., Akron 9, Ohio.

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Live Center. New 2-page Bulletin Q-2B pictures and describes maker's new "Universal" and "Heavy Duty" live centers.—Ideal Industries, Inc., Sycamore, Ill.

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Flexible Shafting. New 12-page Bulletin 525 gives engineering data for power drive and remote control applications of maker's flexible shafting.—Stow Mfg. Co., Binghamton, N. Y.

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Milling Heads. New 4-page illustrated brochure describes maker's large line of vertical milling heads. Includes 32 sizes and models for horizontal milling machines, boring mills and planers.—Brown Vertical Milling Head Co., 1615 Riverside Drive, Los Angeles 31, Calif.

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Calcium Lignosulfonate. New 4-page brochure presents physical and chemical characteristics and list of applications of "Toranil", a de-sugared calcium lignosulfonate.—Lake States Yeast Cor., Rhinelander, Wis.

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Sales Problems. New 4-page issue of "Business Brevities" features article on why salesmen lose business.—Pipe Line Anode Corp., 25th West Ave. & Sand Springs Rd., P. O. Box 996, Tulsa, Okla.

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Production Tools. New 8-page Brochure 38 describes and illustrates maker's line of solenoid-operated production tools.—Black & Webster, Inc., Newton 58, Mass.

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Machining Stainless. New 94-page booklet gives speeds, feeds, and estimating data for machining all types of stainless steel used commonly on automatics.—Republic Steel, 3100 East 45th St., Cleveland 27, Ohio.

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Machine Work. New 20-page Catalog 52-CN describes facilities for jig boring, cam milling, spot welding, butt welding, arc welding, general machine work, fabricating, etc.—Eisler Engineering Co., Inc., 750 South 13th St., Newark 3, N. J.

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Plastic Carrying Cases. New 4-page brochure pictures fabricators plastic carrying cases for a wide variety of products.—Regal Plastic Co., 2800 East 14 St., Kansas City 27, Mo.

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Stapling Machines. New 8-page Bulletin Pr/601 describes and illustrates new "Staple Princess" for single end closing of partial overlap, telescope or center-slotted cartons.—International Staple Machine Co., 809 East Herrin St., Herrin, Ill.

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Spot Welding. Four new 2-page bulletins illustrate and describe maker's spot welders. Includes new spot welding data chart.—Birdsell Mfg. Co., Inc., 750 San Antonio Rd., Palo Alto, Calif.

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Coating Compound. New 2-page bulletin lists applications and specifications and properties of maker's "Logoquant Q-75" coating compound for use on cellulose acetate Butyrate.—Logo Inc., 13799 South Ave. "O", Chicago 33, Ill.

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Hardboard. New 8-page illustrated Booklet OLC-A-54-5 covers production, applications, physical properties and resistance to chemicals of maker's "Allwood" hardboard.—Oregon Lumber Co., Hardboard Div., Dee, Ore.

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Fabricated Plastics. New 2-page illustrated brochure describes maker's valves of unplasticized polyvinyl chloride. Also bolts, nuts, washers, pails, dippers and pitchers.—Industrial Plastic Fabricators, Inc., Endicott St., Norwood, Mass.

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Metal Powders. New 4-page Bulletin 1 discusses art of powder metallurgy and describes general types and applications of maker's metal powder.—Plastic Metals Div., National Radiator Co., Johnstown, Pa.

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Zirconium. New 64-page illustrated Booklet A-1297, presents history, mechanical and physical properties, fabrication data, etc. of zirconium, a new metal.—Carborundum Metals Co., Inc., Akron, N. Y.

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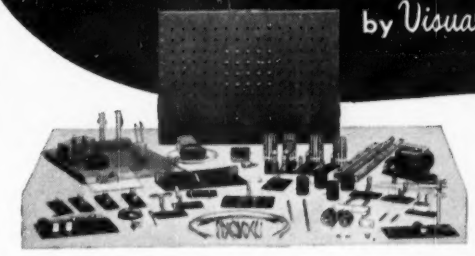

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1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160	201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400	401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640

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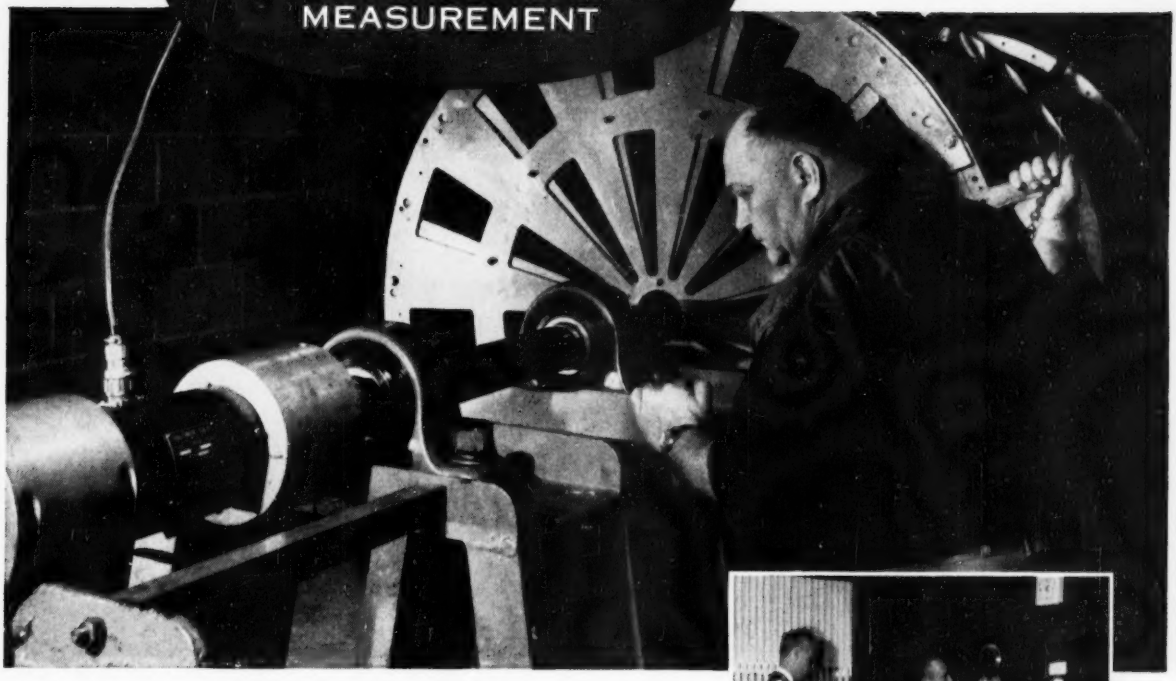

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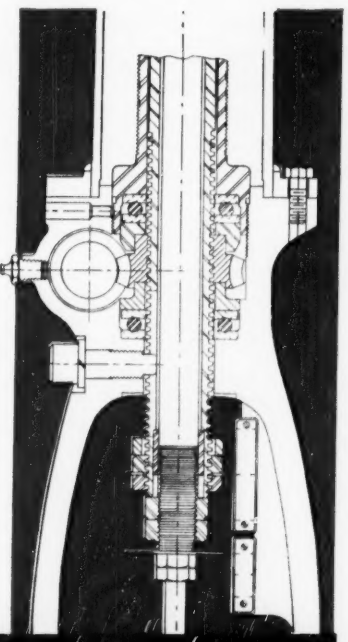

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